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Senecio schultzii Hochst. ex A. Rich. var. *lanatus* Otieno & Mesfin, var. nov.: p. 30

Accredited with the International Association of Plant Taxonomy for the purpose of registration of new namnes of vascular plants (excluding fossils).

Karyological studies on some taxa of the Asteraceae in Egypt

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Abstract

Chromosomal studies have been carried out on 10 species of the Asteraceae representing four tribes in the main two subfamilies Cichorioideae and Asteroideae collected from the flora of Egypt. In this study eight new counts are presented. These studies include detailed characterization of karyological features of each species. The cytological features are obtained from chromosome number, length and criteria of the karyotype asymmetry including chromosome arm ratio, TF% (total form percent), A_1 (the intrachromosomal asymmetry index) and A_2 (the interchromosomal index).

Introduction

The Asteraceae are well represented in the flora of Egypt. TÄCKHOLM (1974) reported 93 genera and 230 species distributed in different habitats of the country (HASSIB 1950), whereas EL-HADIDI & FAYED (1995) reported 92 genera and 226 species. The family is also represented in the weeds of Egypt by 28 species (BOULOS & EL-HADIDI 1989).

The cytological criteria in the Asteraceae show considerable variations. Two contradicting views have been proposed with regard to the basic chromosome number in the family. SOLBRIG (1978) noted that x=9 is the most common basic number and proposed it as the model number of the family. However, MEHRA (1977) proposed x=5 as the basic number in the family. In 1996 KAMEL reported chromosome counts from 47 species of Egyptian Asteraceae and also considered x=5 the ancestral number for the whole family. He suggested that the higher numbers could have been derived from polyploidy cycles and aneuploid variations.

In the present study, chromosome numbers and detailed karyotype features of 10 Egyptian species of the Asteraceae representing four tribes in the main two subfamilies Cichorioideae and Asteroideae are reported.

Materials and Methods

Materials of 10 species belonging to the family Asteraceae were collected from their natural habitats. The studied species and the localities from which they were collected are given in Table 11. Vouchers of the collections are preserved in the herbarium of the Biological Sciences and Geology Department, Faculty of Education, Ain Shams University, Cairo (Egypt).

Cytological preparations were carried out on root tips obtained from seeds germinated on sterile moist filter papers in Petri dishes at 15-20°C. Roots were pretreated with 0.05% colchicine solution for 3-4 hrs. and fixed in Carnoy for 24 hrs. Cytological preparations were made using the Feulgen squash method and well-spread c-metaphase chromosomes were photographed from temporary preparations at a magnification of 2000 ×. Slides of the original karyotypes are also preserved in the Laboratory of Cytogenetics of the same department.

A karyogram for each species was constructed by arranging the chromosomes in homologous pairs by order of their length and arm ratio as measured from the photographic prints. The number of chromosome types was determined as described by Levan et al. (1965). Measurements of chromosome lengths were taken on the same photographs of the karyogram. Karyograms are based on one plate only.

The variation in chromosome length (MCL) and chromosome arm ratio (MAR) within the karyotype has been estimated by calculating the standard error (SE) of these parameters. Karyotype asymmetry deduced from the ratio between the short arms of the chromosomes and their total length was expressed as total form percent (TF%) as proposed by Huziwara (1962). Karyotype asymmetry expressed by the ratio between the chromosome arms has been also estimated as the intrachromosomal asymmetry index (A_1) as suggested by Romero Zarco (1986). The value of A_1 is framed as to be close to zero if all chromosomes are metacentric and near to one if all chromosomes are telocentric. Karyotype asymmetry due to the ratio between size of different chromosomes has been also estimated as the interchromosomal asymmetry (A_2) using Pearson's dispersion coefficient, that is the ratio between the standard deviation and the mean chromosome length (Romero Zarco 1986).

The existence of previous chromosome counts for the studied species has been verified in the index of plant chromosome numbers by FEDOROV (1969), GOLDBLATT (1981, 1984, 1985, 1988) and GOLDBLATT & JOHNSON (1990, 1991, 1994, 1996).

Results

The summary of the cytological features of the investigated species is shown in Table 11 and the karyotypes are illustrated in Fig. 1.

Subfamily: Cichorioideae

Tribe: Cardueae

1 - Carduus pycnocephalus L.

The examined material of this species was found to be hexaploid with a somatic chromosome number of 2n=54 and basic number of x=9. The karyotype is comprised of metacentric chromosomes in six groups. The chromosomes are short (MCL=1.34±14μm), the MAR is 1.30±0.02 and TF% is 43.64. The symmetry of the karyotype is also indicated by the values of A_1 (0.23) and A_2 (0.31). Detailed measurements of this species are presented in Table 1.

Table 1. Measurements of somatic chromosomes of *Carduus pycnocephalus* L.

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromo-some type
1	2.15	17.77	0.95	1.20	1.26	10.75	m
2	1.72	14.21	0.77	0.95	1.23	10.49	m
3	1.55	12.81	0.68	0.87	1.28	10.92	m
4	1.44	11.90	0.63	0.81	1.29	11.01	m
5	1.32	10.91	0.56	0.76	1.36	11.60	m
6	1.07	8.84	0.48	0.59	1.23	10.49	m
7	0.99	8.18	0.43	0.56	1.30	11.09	m
8	0.98	8.10	0.41	0.57	1.39	11.86	m
9	0.88	7.27	0.37	0.51	1.38	11.77	m
Total	12.10	99.99	5.28	6.82	11.72	99.98	--
Mean ± SE	1.34 ± 0.14	--	0.58 ± 0.06	0.76 ± 0.08	1.30 ± 0.02	--	--

Tribe: Lactuceae

*2 - **Garhadiolus hedypnois*** (FISCH. et MEY.) JAUB. et SP.

This species has a somatic chromosome number of 2n=12 in 6 homologous pairs. The karyotype consists of 2m and 4sm chromosome pairs. The MCL is 2.99±0.23µm, the MAR is 2.07±0.29, the TF% is 34.00, the A_1 is 0.46 and the A_2 is 0.19. The detailed measurements of this species are found in Table 2.

Table 2. Measurements of somatic chromosomes of *Garhadiolus hedypnois* (FISH. et MEY.) JAUB. et SP.

Chr. pair	Chr. length (µm)	Relative length	Short arm (µm)	Long arm (µm)	R. value	Relative R. value	Chromo-some type
1	3.75	20.94	1.63	2.12	1.30	10.46	m
2	3.41	19.04	1.07	2.34	2.19	17.62	sm
3	3.00	16.75	0.80	2.20	2.75	22.12	sm
4	2.95	16.47	0.75	2.20	2.93	23.57	sm
5	2.60	14.52	0.87	1.73	1.99	16.01	sm
6	2.20	12.28	0.97	1.23	1.27	10.22	m
Total	17.91	100.00	6.09	11.82	12.43	100.00	--
Mean ± SE	2.99 ± 0.23	--	0.02 ± 013	1.97 ± 0.17	2.07 ± 0.29	--	--

*3 - **Picris damascena*** BOISS. et GAILL.

A somatic chromosome number of 2n=10 in only five homologous pairs was recorded in this species. The karyotype consists of 1m and 4sm chromosome pairs. The MCL is 2.67±0.24μm, the MAR is 1.84±0.08, the TF% is 35.53, A_1 is 0.45 and A_2 is 0.20. Detailed chromosome measurements are presented in Table 3.

Table 3. Measurements of somatic chromosomes of *Picris damascena* BOISS. et GAILL.

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromo-some type
1	3.40	25.49	1.34	2.06	1.54	16.72	m
2	2.78	20.84	0.94	1.84	1.96	21.28	sm
3	2.70	20.24	0.90	1.80	2.00	21.72	sm
4	2.54	19.04	0.88	1.66	1.89	20.52	sm
5	1.92	14.39	0.68	1.24	1.82	19.76	sm
Total	13.34	100.00	4.74	8.60	9.21	100.00	--
Mean ± SE	2.67 ± 0.24	--	0.95 ± 0.11	1.72 ± 0.14	1.84 ± 0.08	--	--

4 - Thrincia tripolitana SCH.-BIP.

The examined material of this species has only 2n=8 and x=4. The karyotype is comprised of 1m and 3sm pairs. The MCL is 1.90±0.16μm and the MAR is 1.89±0.29. The asymmetry of the karyotype is reflected by the values of TF%(35.00), A_1 (0.42) and A_2 (0.17). Detailed measurements are presented in Table 4.

Table 4. Measurements of somatic chromosomes of *Thrincia tripolitana* SCH.- BIP.

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromo-some type
1	2.36	31.05	0.68	1.68	2.47	32.63	sm
2	1.90	25.00	0.60	1.30	2.17	28.67	sm
3	1.70	22.37	0.60	1.10	1.83	24.17	sm
4	1.64	21.58	0.78	0.86	1.10	14.53	m
Total	7.60	100.00	2.66	4.94	7.57	100.00	--
Mean ± SE	1.90 ± 0.16	--	0.67 ± 0.04	1.23 ± 0.17	1.89 ± 0.29	--	--

Subfamily: Asteroideae

Tribe: Inuleae

5 - Anvillea garcini (BURM. f.) DC.

In this species a somatic number of 2n=14 and x=7 were found. The karyotype consists of 5 pairs of metacentric chromosomes and 2 pairs of submetacentric chromosomes. The MCL is 2.79±0.11µm. The MAR is 1.66±0.21 and the TF% is 38.97. The karyotype asymmetry indices A_1 and A_2 are 0.36 and 0.11 respectively. The measurements of chromosomes are found in Table 5.

Table 5. Measurements of somatic chromosomes of *Anvillea garcini* (BURM. f.) DC.

Chr. pair	Chr. length (µm)	Relative length	Short arm (µm)	Long arm (µm)	R. value	Relative R. value	Chromosome type
1	3.36	17.23	1.44	1.92	1.33	11.44	m
2	2.94	15.08	1.16	1.78	1.53	13.16	m
3	2.80	14.36	1.14	1.66	1.46	12.55	m
4	2.72	13.95	1.22	1.50	1.23	10.58	m
5	2.72	13.95	1.00	1.72	1.72	14.79	sm
6	2.48	12.72	1.00	1.48	1.48	12.73	m
7	2.48	12.72	0.64	1.84	2.88	24.76	sm
Total	19.50	100.01	7.60	11.90	11.63	100.01	--
Mean ± SE	2.79 ± 0.11	--	1.09 ± 0.09	1.70 ± 0.06	1.66 ± 0.21	--	--

6 - Gymnarrhena micrantha DESF.

A somatic chromosome number of 2n=20 in 10 homologous pairs of 1M and 9m chromosomes was recorded in this species. The calculated MCL is 1.48±0.07 μm and MAR is 1.25±0.04. The TF% is 44.53, the A_1 is 0.19 and A_2 is 0.14. Chromosome measurements are found in Table 6.

Table 6. Measurements of somatic chromosomes of *Gymnarrhena micrantha* DESF.

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromo-some type
1	1.80	12.15	0.76	1.04	1.37	10.98	m
2	1.70	11.47	0.72	0.98	1.36	10.90	m
3	1.60	10.80	0.74	0.86	1.16	9.29	m
4	1.56	10.53	0.74	0.82	1.11	8.89	m
5	1.56	10.53	0.64	0.92	1.44	11.54	m
6	1.50	10.12	0.68	0.82	1.21	9.70	m
7	1.40	9.45	0.60	0.80	1.33	10.66	m
8	1.36	9.18	0.68	0.68	1.00	8.01	M
9	1.26	8.50	0.56	0.70	1.25	10.02	m
10	1.08	7.29	0.48	0.60	1.25	10.02	m
Total	14.82	100.02	6.60	8.22	12.48	100.01	--
Mean ± SE	1.48 ± 0.07	--	0.66 ± 0.03	0.82 ± 0.04	1.25 ± 0.04	--	--

*7 - **Jasonia montana*** (VAHL) BOTSCH.

The examined material of this species was found to be diploid with a somatic chromosome number of 2n=16 and a basic chromosome number of x=8. The karyotype of this species consists of 7 pairs of metacentric chromosomes and one pair of submetacentric chromosomes. The MCL is 2.09±0.15 μm. The karyotype symmetry measures i.e. MAR (1.36±0.08), the TF% (42.82), A_1 (0.25) and the A_2 (0.20) indicate a high degree of symmetry in the karyotype of this species. Measurements of chromosomes are found in Table 7.

Table 7. Measurements of somatic chromosomes of *Jasonia montana* (VAHL) BOTSCH.

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromo-some type
1	2.90	17.34	1.28	1.62	1.27	11.67	m
2	2.40	14.35	1.08	1.32	1.22	11.21	m
3	2.24	13.40	1.06	1.18	1.11	10.20	m
4	2.08	12.44	0.74	1.34	1.81	16.64	sm
5	2.00	11.96	0.84	1.16	1.38	12.68	m
6	1.80	10.77	0.70	1.10	1.57	14.43	m
7	1.76	10.53	0.74	1.02	1.38	12.68	m
8	1.54	9.21	0.72	0.82	1.14	10.48	m
Total	16.72	100.00	7.16	9.56	10.88	99.99	--
Mean ± SE	2.09 ± 0.15	--	0.90 ± 0.08	1.19 ± 0.08	1.36 ± 0.08	--	--

Tribe: Anthemideae

8 - Anthemis melampodina DEL.

This species has a somatic chromosome number of 2n=18 in 9 homologous pairs. The karyotype consists of 5m, 3sm and 1st chromosome pairs. This species has the longest chromosomes of the species here studied (MCL=3.85±18μm). The MAR is 1.89±0.27. The asymmetry of the karyotype of this species is also indicated by the values of TF% (37.08), A_1 (0.40) and A_2 (0.14). Detailed measurements are presented in Table 8.

Table 8. Measurements of somatic chromosomes of *Anthemis melampodina* DEL.

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromosome type
1	4.76	13.73	2.20	2.56	1.16	6.81	m
2	4.42	12.75	1.80	2.62	1.46	8.57	m
3	4.26	12.28	1.78	2.48	1.39	8.16	m
4	3.84	11.07	1.30	2.54	1.95	11.44	sm
5	3.68	10.61	1.66	2.02	1.22	7.16	m
6	3.58	10.32	0.80	2.78	3.48	20.42	st
7	3.54	10.21	0.92	2.62	2.85	16.73	sm
8	3.52	10.15	1.14	2.38	2.09	12.27	sm
9	3.08	8.88	1.26	1.82	1.44	8.45	m
Total	34.68	100.00	12.86	21.82	17.04	100.01	--
Mean ± SE	3.85 ± 0.18	--	1.43 ± 0.15	2.42 ± 0.10	1.89 ± 0.27	--	--

9 - A. microsperma Boiss & Ky.

A somatic chromosome number of 2n=18 and x=9 are also recorded in this species. The karyotype consists of 1M and 8m chromosome pairs. The chromosomes of this species are shorter than those of the previous species (MCL=2.14±0.25µm). The MAR are lower, but the TF% (43.97) is higher reflecting the presence of only metacentric chromosomes in the karyotype. The karyotype symmetry is also reflected by the indices of A_1 and A_2, viz. 0.20 and 0.35 respectively. The detailed chromosome measurements are found in Table 9.

Table 9. Measurements of somatic chromosomes of *Anthemis microsperma* Boiss. & Ky.

Chr. pair	Chr. length (µm)	Relative length	Short arm (µm)	Long arm (µm)	R. value	Relative R. value	Chromo-some type
1	3.94	20.48	1.76	2.18	1.24	10.84	m
2	2.52	13.10	1.10	1.42	1.29	11.28	m
3	2.24	11.64	0.86	1.38	1.60	13.99	m
4	2.06	10.71	0.90	1.16	1.29	11.28	m
5	1.94	10.08	0.82	1.12	1.37	11.97	m
6	1.76	9.15	0.80	0.96	1.20	10.49	m
7	1.72	8.94	0.78	0.94	1.21	10.58	m
8	1.66	8.63	0.74	0.92	1.24	10.84	m
9	1.40	7.28	0.70	0.70	1.00	8.74	M
Total	19.24	100.01	8.46	10.78	11.44	100.01	--
Mean ± SE	2.14 ± 0.25	--	0.94 ± 0.11	1.20 ± 0.14	1.27 ± 0.05	--	--

10 - Cotula anthemoides L.

This species has a somatic chromosome number of 2n=20 in 10 homologous pairs. The karyotype is composed of 5m and 5sm chromosome pairs. The MCL is 3.00±0.20 μm, MAR is 1.62±0.10 and the TF% is 37.95. The karyotype asymmetry is also indicated by A_1 and A_2 values (0.36 and 0.22 respectively). The chromosome measurements are presented in Table 10.

Table 10. Measurements of somatic chromosomes of *Cotula anthemoides* L.

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromo-some type
1	4.14	13.78	1.32	2.82	2.14	13.19	sm
2	3.56	11.85	1.52	2.04	1.34	8.26	m
3	3.52	11.72	1.20	2.32	1.93	11.89	sm
4	3.44	11.45	1.18	2.26	1.92	11.83	sm
5	3.00	9.99	1.10	1.90	1.73	10.66	sm
6	2.78	9.25	1.00	1.78	1.78	10.97	sm
7	2.76	9.19	1.20	1.56	1.30	8.01	m
8	2.40	7.99	0.98	1.42	1.45	8.93	m
9	2.24	7.46	1.00	1.24	1.24	7.64	m
10	2.20	7.32	0.90	1.30	1.40	8.63	m
Total	30.04	100.00	11.40	18.64	16.23	100.01	--
Mean ± SE	3.00 ± 0.20	--	0.14 ± 0.06	1.86 ± 0.16	1.62 ± 0.10	--	--

Discussion

Of the 10 species studied of the Asteraceae from the Egyptian flora chromosome counts are observed for eight species for the first time. These new chromosome counts are recorded in; *Garhadiolus hedypnois* (2n=12), *Picris damascena* (2n=10), *Thrincia tripolitana* (2n=8), *Gymnarrhena micrantha* (2n=20), *Jasonia montana* (2n=16), *Anthemis melampodina* (2n=18), *A. microsperma* (2n=18) and *Cotula anthemoides* (2n=20).

The numbers recorded for the other two species, i.e. 2n=54 in *Carduus pycnocephalus* and 2n=14 in *Anvillea garcini,* are previously reported (Fedorov 1969, Goldblatt & Johnson 1990, 1996 and Goldblatt 1985, Goldblatt & Johnson 1996, resp.).

In *Carduus pycnocephalus* 2n=18, 32, 60 and 64 are previously recorded (Goldblatt 1981-1988, Goldblatt & Johnson 1990-1996). For *Garhadiolus hedypnois* 2n=10 was recorded in Fedorov (1969). Also, in *Cotula anthemoides* 2n=36 is previously reported in Fedorov (1969). Polyploidy is recorded only in *Carduus pycnocephalus* with 2n=54 and x=9.

Karyological studies were carried out for the first time for all the studied species. The karyotype analysis of the studied species shows that *Anthemis melampodina* has the longest chromosomes (MCL=3.85±0.18μm), whereas *Carduus pycnocephalus* has the shortest chromosomes (MCL=1.34±0.14μm). Four of the karyotypes studied are found to be symmetric with TF% above 40 and five with TF% above 35. The highest value of TF% (44.53) was found in *Gymnarrhena micrantha*, whereas the lowest (34.00) was found in *Garhadiolus hedypnois*. The values of the TF% for the studied species thus support previous observations (Huziwara 1962, Mehra 1977 and Badr et al. 1997) that the karyotype in the Asteraceae is symmetric. The calculated MAR and A_1 values are generally low in all species which is in general agreement with the assumption that the karyotype in the family is symmetric.

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Table 11. Localities and cytological features of the studied taxa. Collected by E. A. KAMEL; vouchers in Ain Shams University, Cairo, Egypt.

MCL=mean chromosome length
MAR=mean arm ratio
SE= standard error
TF%=total form percent
A_1= intrachromosomal asymmetry index
A_2=interchromosomal asymmetry index
m=metacentric chromosome
M=metacentric point chromosome
sm=submetacentric chromosome
st=subtelocentric chromosome
Asterisks indicate new chromosome counts.

Sp.no.	Tribe	Species	Locality	Date of collection	2n	MCL.SE (μm)	MAR SE	TF%	A_1	A_2	Chr. Type			
											M	m	sm	st
1	Cardueae	*Carduus pycnocephalus* L.	Cairo - Alex. Agr. Road 160 km	4.4.97	54	1.34 ± 0.14	1.30 ± 0.02	43.64	0.23	0.31	-	9	-	-
2	Lactuceae	*Garhadiolus hedypnois* (FISCH. et MEY.) JAUB. et SP. *	Bourg El-Arab	2.4.97	12	2.99 ± 0.23	2.07 ± 0.29	34.00	0.46	0.19	-	2	4	-
3	"	*Picris damascena* BOISS. et GAILL.*	Alex. – Matruh Road	31.3.97	10	2.67 ± 0.24	1.84 ± 0.08	35.53	0.45	0.20	-	1	4	-
4	"	*Thrincia tripolitana* SCH.-BIP. *	Bourg El-Arab Marakia	2.4.97	8	1.90 ± 0.16	1.89 ± 0.29	35.00	0.42	0.17	-	1	3	-
5	Inuleae	*Anvillea garcini* (BURM. f.) DC.	Cairo – Suez Road	24.3.97	14	2.79 ± 0.11	1.66 ± 0.21	38.97	0.36	0.11	-	5	2	-
6	"	*Gymnarrhena micrantha* DESF. *	Alex. – Matruh Road	31.3.97	20	1.48 ± 0.07	1.25 ± 0.04	44.53	0.19	0.14	1	9	-	-
7	"	*Jasonia montana* (VAHL) BOTSCH. *	Wadi Al-Arbeain-San Cathreen-Sinai	8.4.95	16	2.09 ± 0.15	1.36 ± 0.08	42.82	0.25	0.20	-	7	1	-
8	Anthemideae	*Anthemis melampodina* DEL. *	Cairo – Suez Road	24.3.97	18	3.85 ± 0.18	1.89 ± 0.27	37.08	0.40	0.14	-	5	3	1
9	"	*Anthemis microsperma* BOISS. & KY. *	Cairo – Alex. desert Road	2.4.97	18	2.14 ± 0.25	1.27 ± 0.05	43.97	0.20	0.35	1	8	-	-
10	"	*Cotula anthemoides* L. *	Cairo – Alex. desert Road/Bourg El-Arab	2.4.97	20	3.00 ± 0.20	1.62 ± 0.10	37.95	0.36	0.22	-	5	5	-

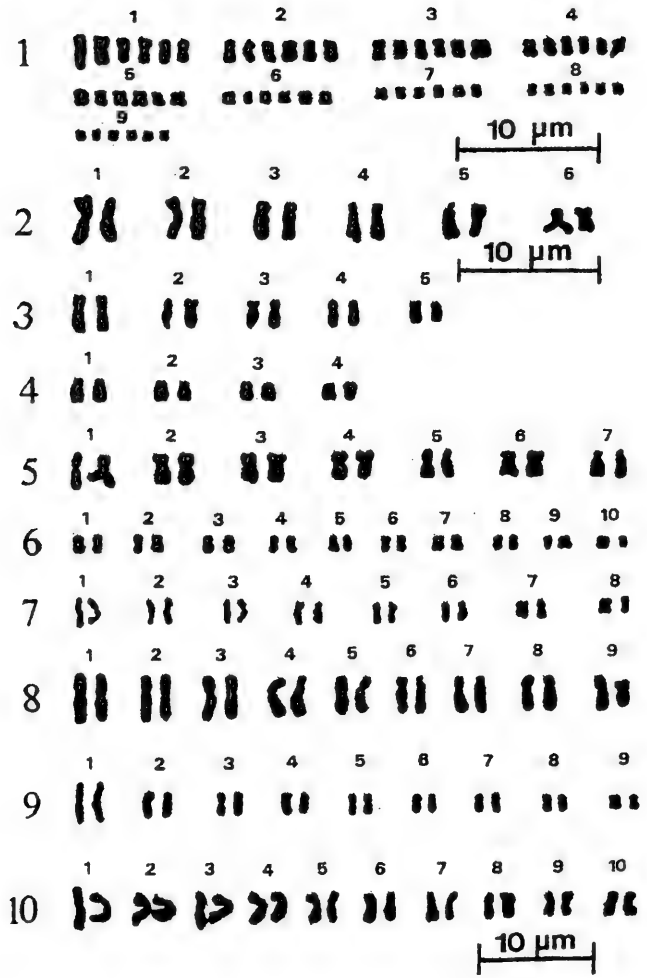

Fig. 1. Karyotype of the studied species of the Asteraceae.

(1) *Carduus pycnocephalus*
(2) *Garhadiolus hedypnois*
(3) *Picris damascena*
(4) *Thrincia tripolitana*
(5) *Anvillea garcini*
(6) *Gymnarrhena micrantha*
(7) *Jasonia montana*
(8) *Anthemis melampodina*
(9) *A. microsperma*
(10) *Cotula anthemoides*

New chromosome counts for some Western Australian Gnaphalieae (Compositae)

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Abstract

Chromosome numbers for *Ozothamnus ramosus* ($n = 14$), *Pithocarpa corymbulosa, P. pulchella* (both $n = 13$), and *Rhodanthe psammophila* ($n = 5$), are reported and briefly discussed.

Introduction

The Gnaphalieae is among the largest tribes of the Compositae, comprising over 180 genera and 2000 species distributed throughout the world (Bremer 1994). However, unlike some other tribes of the Compositae (e.g. Heliantheae), there have been few cytological studies dealing with members of the Gnaphalieae (Turner 1977, Anderberg 1991).

As part of a study of the systematics of the genus *Pithocarpa* Lindl. by the first author (Lepschi 1997), chromosome numbers of all three taxa in that genus (see Table 1) as well as in *Ozothamnus ramosus* (DC.) Paul G. Wilson and *Rhodanthe psammophila* Paul G. Wilson were determined. This paper presents chromosome counts for these taxa, none of which appear to have been previously recorded, apart

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from *R. psammophila* (see under *Helipterum condensatum* F. MUELL., in TURNER 1970). It should be noted that *O. ramosus* does not belong to *Ozothamnus* sens. str., and will be transferred to a new genus along with a handful of other Australian species currently placed in *Ozothamnus* (C. F. PUTTOCK pers. comm.).

Materials and Methods

Young, freshly collected buds were placed in a solution of 4 parts chloroform, 3 parts 95% alcohol and 1 part acetic acid. These were subsequently transferred to an acetocarmine stain, with meiotic material then examined after "squashing" pollen mother cells. Counts were made using a binocular compound microscope with an oil immersion achromatic lens giving a magnification of approximately ×1000, with up to five counts made per collection. All bud material was collected from wild plants in the field, except for *R. psammophila,* for which material was collected from plants in cultivation. Vouchers for all counts are deposited at PERTH.

Results and Discussion

Results obtained from this study are presented in Table 1. Taxa are arranged alphabetically.

Table 1. Chromosome numbers in some Western Australian Gnaphalieae.

Taxon	Chromosome number (n)	Voucher
Ozothamnus ramosus (DC.) PAUL G. WILSON	14	LEPSCHI & LALLY 3307
Pithocarpa corymbulosa LINDL.	13	LEPSCHI 3858
P. pulchella LINDL. var. *pulchella*	13 13	LEPSCHI & LALLY 2552 LEPSCHI & LALLY 2561
P. pulchella var. *melanostigma* (P. LEWIS & SUMMERH.) LEPSCHI ined.	13	LEPSCHI & LALLY 3401
Rhodanthe psammophila PAUL G. WILSON	5	LEPSCHI 3099

The paucity of cytological studies on the Gnaphalieae unfortunately limits what inferences can be drawn from the data presented here. However, some general observations can be made. SOLBRIG et al. (1964) and SOLBRIG (1977) note that in the Compositae, perennial species generally have higher chromosome numbers (i.e. greater than $n = 9$) while annual species, particularly those from arid areas, tend to have lower chromosome numbers. Our data agrees with that of SOLBRIG et al. (1964) and SOLBRIG (1977), with *O. ramosus* ($n = 14$) and *Pithocarpa* spp. ($n = 13$) being perennial species from the relatively mesic south-west of Western Australia, and with *R. psammophila* ($n = 5$) being an annual species restricted to the Carnarvon district in eremean Western Australia.

Breeding systems and chromosome numbers may also show some correlation, with higher chromosome numbers (i.e. greater than $n = 9$), often found in outbreeding taxa in the Compositae (SOLBRIG 1977). Studies by the first author (LEPSCHI 1997), suggest that all *Pithocarpa* spp. are outbreeders, and the corresponding chromosome number of $n = 13$ for all taxa in the genus is consistent with this. The breeding systems of the other taxa included in this study have yet to be determined.

Direct comparison of chromosome counts obtained for taxa in this study with those of related species is unfortunately not possible for most taxa. The only published chromosome counts for species of *Ozothamnus* are those reported in HAIR & BEUZENBERG (1968) for seven New Zealand species (as *Helichrysum* spp.), all of which are $n = 14$. However, as mentioned above, *O. ramosus* does not belong in *Ozothamnus* sens. str., and comparison of chromosome numbers in this taxon and the New Zealand species would not be particularly meaningful at this stage, except for relationships at the generic level. Further taxonomic and cytological studies on *Ozothamnus* are urgently required.

The count of $n = 5$ obtained for *R. psammophila* confirms that reported by TURNER (1970; as *Helipterum condensatum*). *Rhodanthe* LINDL., as presently circumscribed, is a heterogeneous assemblage (ANDERBERG 1991, P. G. WILSON pers. comm.) the members of which exhibit great variation in chromosome numbers. As with *Ozothamnus,* further systematic and cytological studies are needed to clarify the significance of this variation. The relationships of *Pithocarpa* are not clear, but the results of a recent phylogenetic study of *Pithocarpa* (LEPSCHI 1997), suggest that its closest affinities may be with taxa of the *'Lawrencella* complex' of genera (sensu ANDERBERG 1991). However, LEPSCHI (1997) studied only a selection of the potential relatives of *Pithocarpa* (including *Argentipallium niveum* (STEETZ) PAUL G. WILSON and *O. ramosus* of the *Lawrencella* complex), and a more comprehensive sampling of taxa would be required to accurately determine the sister taxon to *Pithocarpa.*

Data on chromosome numbers in genera of the *Lawrencella* complex is poor, but chromosome numbers of $n = 8$, 11 and c. 24 have been reported (TURNER 1970). ANDERBERG (1991) also records $n = 14$, but this appears to be in error. *Argentipallium niveum,* which appears as the sister taxon to *Pithocarpa* in the analysis of LEPSCHI (1997) has a chromosome number of $n =$ c. 24 (TURNER 1970; as *Helipterum obtusifolium* SOND.).

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New combinations, varieties and synonyms in African Compositae

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Abstract

The following notes were gathered during the writing of the account of the Compositae for the Flora of Ethiopia and while revising *Bidens* and *Coreopsis*. As the publication of the volume containing the Compositae will not be forthcoming in the near future, some new combinations, synonyms and varieties in the tribes Astereae, Cardueae, Heliantheae, Inuleae, Lactuceae and Senecioneae are provided here.

Astereae

1. *Conyza* LESS.

Conyza hypoleuca A. RICH., Tent. Fl. Abyss., vol. 1, p. 391 (1848).

Microglossa elliotii S. MOORE, J. Linn. Soc. Bot. 35: 327 (1902); CUFODONTIS, Enumeratio Plantarum Aethiopiae, sequentia, Bull. Jard. Bot. Nat. Belg. 37, Suppl.: 1084 (1967), **synon. nov.** Type: Kenya, Naivasha, ELLIOT 7034 (BM!, holotype).

Other specimen: Kenya, Masai, ELLIOT 6589 (BM!).

2. *Felicia* CASS.

Felicia abyssinica SCH. BIP. ex A. RICH., Tent. Fl. Abyss., vol. 1, p. 383 (1848).

This is a polymorphic species currently known from the north-eastern parts of Sudan down to Zambia. It is made up of populations that show some variations in the density of the indumentum on various parts of the plant, size of leaves and height of the plant. These variations can be recognized as follows:

1. Peduncle, phyllaries and often also leaves with dense, capitate-glandular hairs intermixed with simple flexuous hairs ..... 1. var. *abyssinica*
– Peduncle, phyllaries and leaves with simple, stiff and bristly hairs, internodes densely pilose, white 2

2. Leaves 5-10 (-25) x 1-2 mm; plant up to 15 cm high ..... 2. var. *schimperi*
– Leaves 10-30 x (1-) 2-3 mm; plant 20-40 cm high ..... 3. var. *neghelliensis*

1. var. ***abyssinica***

Felicia abyssinica subsp. *abyssinica* sensu Grau in Mitt. Bot. Staats. Münch. 9: 195–705 (1973).

This variety is confined to the northern parts of Ethiopia and Eritrea and adjacent parts of Sudan (i.e., Kassala Prov., Red Sea Hills).

Selected specimens: Eritrea: Senafe, 19 Aug. 1959, Mooney 7986 (ETH, K), 11 Sept. 1954, Colville 59 (K); N Sahil, 1986, Jones 107 (K); Akale Guzai, Halai, 11 May 1902, Pappi (5224) 87 (K); Saganeiti, 21 April 1892, Schweinfurth & Riva 1738 (K). **Ethiopia**: Tigrai, Urahut, Jan. 1839, Schimper 1763 (K), and 813 (K); Adigrat, 20 Jan. 1963, Tekle H. Hagos 167 (ETH, K); no data, Petit s.n. (K), Quartin-Dillon & Petit s.n. (K), G. Aweke & Gilbert 772 (ETH, K). **Sudan**: Red Sea Hills, Diris Pass, 10 April 1953, Jackson 2890 (K); Kassala Prov., March 1938, Cook K2 (K).

2. var. ***schimperi*** (Steud. & Hochst. ex Jaub. & Spach) Mesfin, **comb. nov.**

Felicia schimperi Steud. & Hochst. ex Jaub. & Spach., Illust. Pl. Or. 4: 86, Table 354 (1852). Type: Arabia Felix (= Yemen), Cara, Schimper 858 (?B, holotype, K isotype!)

Felicia abyssinica Sch. Bip. ex A. Rich. subsp. *neghelliensis* Grau, loc. cit. (1973), quoad specim. ex Ethiop. (p.p.), Yemen et Somalia.

This variety is known from Yemen, eastern and south-central Ethiopia and Somalia. In habit, it resembles var. *abyssinica* but differs from it by the absence of the capitate glandular hairs. From var. *neghelliensis* is differs by its narrower and often smaller leaves and smaller size.

Selected specimens: Ethiopia: Shewa, between Awash & Meki rivers, 1898 and 1899, Wellby s.n. (K, two specimens); 5 km S of Meki, 26 July 1972, M.G. & S.B. Gilbert & Tewolde 2476 (ETH, K); Keffa, Jimma, 12 Aug. 1961, Brehme in Mooney 9088 (ETH, K); Hararge, Diredawa, Dec. 1957, Iecama A-8 (K); Garamuletta, 5 May 1960, Iecama H-37 (K); Jijiga, 24 July 1959, Sandford in Mooney 7957 (K).

3. var. ***neghelliensis*** (CUFOD.) MESFIN, **comb. nov.**

Felicia neghelliensis CUFOD., Nuovo Giorn. Bot. Ital. 50: 104 (1943), Enumeratio Plantarum Aethiopiae, sequentia. - Bull. Jard. Bot. Nat. Belg. 37, Suppl.: 1083 (1967); *F. abyssinica* SCH. BIP. ex A. RICH. subsp. *neghelliensis* (CUFOD.) GRAU, 1973: 404. Type: Ethiopia, [Sidamo], Neghelli, CORRADI 1952, 1957, 1967, 1968, 1999 and 2000 (?FT, syntypes).

CUFODONTIS (1943) cited the above specimens when he described the taxon. In 1967, he substituted "CUFODONTIS 166 (Neghelli, 10 km Malca-Guba versus)" for the above types but gave no explanation.

?F. hyssopifolia sensu CUFOD., loc. cit. (1967) non (BERG.) NEES (1822), quoad BURGER 1722 et 3056.

Selected specimens: Ethiopia: Sidamo, 25 m. W of Neghelle, Cure Liban, 21 Sept. 1953, BALLY 9297 (EA); 33 km on Negelle-Filtu road, 20 May 1982, FRIIS et al. 3129 (ETH, K), 35 km on Negelle-Filtu road, 2 Nov. 1972, FRIIS et al. 921 (ETH, K); 16 km NNE of Yavello, 13 May 1976, GILBERT & JEFFORD 4469 (ETH, K); 13 km on Megado-Mega track, 25 May 1986, MESFIN & VOLLESEN 4332 (ETH, K). **Somalia**: Erigavo, 26 Jan. 1945, GLOVER & GILLILAND 657 (K); Tabah Pass, road from Erigavo to Mait, 31 July 1957, NEWBOULD 783 (K); Hargeissa, Oct. 1961, HEMMING 2242 (K); Gah Libah, 3 Nov. 1956, BALLY 11307 (EA). **Kenya**: (K1): NEWBOULD 3529 (K), (K3): BOGDAN 3685 (K), NEWBOULD (3304); (K4): GILBERT 6089 (K), NAPIER 2408 (K).

Cardueae

1. *Carduus* L.

Carduus macracanthus SCH. BIP. EX KASMI

Carduus macracanthus KASMI, Mitt. Bot. Staats. München 5: 164 (1983), **nom. non rite publ.**; *C. macracanthus* SCH. BIP. in SCHWEINF. & ASCHERS., Beitr. Fl.Aethiop.: 283 (1867), in OLIVER & HIERN, Fl. Trop. Afr. 3: 434 (1877), in FRIES, Acta Horti Berg. 8: 35 (1925), nom.nud. Type: Ethiopia, SCHIMPER 51 (G holotype; B, K! P, isotypes).

OLIVER & HIERN (1877) recorded *Carduus macracanthus* SCH. BIP. as a doubtful and unknown species, doubtful because they saw only "a single involucral bract with a pinnatifid spine, lent from the Berlin Herbarium". Recent specimens of the species, collected from high mountains (between 3950 - 4000 m) in Ethiopia, have confirmed its existence and it can be distinguished from close relatives by its wider (2.5-3.5 mm

at base versus less than 2 mm) phyllaries with sharply laciniate (versus entire or hispid) margins and its dense white-woolly pubescence.

Specimens: Ethiopia: W. DE WILDE 9187 (K), HEDBERG 5623 (ETH, K, UPS), MESFIN T. 7837 (ETH).

Heliantheae

1. *Guizotia* CASS.

In a recent cytological study on *Guizotia,* KIFLE DAGNE & HENEEN (1992) and KIFLE DAGNE (1994,1995) showed that *G. schimperi* SCH. BIP. ex WALP. (given in their paper as *G. scabra* subsp. *schimperi*) is closer to *G. abyssinica* (L.f.) CASS. than to *G. scabra* (VIS.) CHIOV. (given as *G. schimperi* subsp. *scabra*). The latter species is also found to be more closely related to *G. villosa* SCH. BIP. ex WALP. than to *G. schimperi.* The study, which included material from wild populations for a number of the species, revealed "... three groups [of species] indicating possible phylogenetic relationships". KIFLE DAGNE (1995: 133) also stated that "on the basis of chromosome morphology, ... the Chelelu population (i.e., *G. schimperi* from Shewa in Ethiopia) seems to be more related to *G. abyssinica* and *G. scabra* subsp. *schimperi*". The individuals representing this population, which were collected from a riverine habitat, were also suggested to be the progenitors of *G. scabra* subsp. *schimperi* (= *G. schimperi*). In the same work, the earlier hypothesis by BAAGOE (1974) i. e., that *G. abyssinica* might have been derived either from an unknown wild progenitor or from *G. scabra* subsp. *schimperi*, was also reiterated. KIFLE DAGNE (1995: 134), who also studied wild populations of typical *G. scabra* (from Ketcha in Bale region, Ethiopia) found that these populations are "... generally similar to those of *G. scabra* subsp. *scabra*."

The present author has also studied the morphology of some wild populations of *G. scabra* and *G. schimperi,* and it appears that the differences between them are concealed by the presence of a large number of individuals with intermediate features. These intermediates are weedy plants and are often encountered in and around cultivated fields. They may be annual or perennial plants with variable foliar and capitular features. When the collections made of such populations represent annual plants, they are often identified, in herbaria, as *G. scabra* subsp. *schimperi.* Often these plants grow with annual crops such as *Eragrostis tef* (ZUCC.) TROTT., *Guizotia abyssinica*, etc., in Ethiopia. When left growing in the fields or at the margins, some of these weedy plants perennate, and, if collected in this state, the specimens are determined as *G. scabra* subsp. *scabra.*

In these taxa, the question is not that of incipient speciation, as believed by BAAGOE (1974), but that of continuous hybridization probably accompanied by backcrosses between the two well defined species, *G. scabra* and *G. schimperi.* Although the studies by KIFLE DAGNE and W. K. HENEEN (loc. cit.) are not conclusive about the extent of hybridization within *Guizotia*, KIFLE DAGNE, in particular (1994:127) wrote, "in view of the rather high level of crossability among the present taxa, it is very probable that introgression can take place between any two of these taxa whenever they happen to grow together."

Consequent to these studies, it becomes necessary to recognize the two taxa as distinct species.

Guizotia scabra (VIS.) CHIOV., Ann. Ist. Bot. Roma 8: 184 (1904).

Guizotia scabra subsp. *scabra* sensu BAAGOE, Bot. Tidsskr. 69: 25 (1974), **synon. nov.** Type: Sudan, Fazokel, Tumad, Kassa, KOTSCHY 501 (FI lecto.; K!, W!).

Guizotia schimperi SCH. BIP. ex WALP., Rep. Bot. Syst. 6: 158 (1846).

Guizotia scabra subsp. *schimperi* (SCH. BIP. ex A. RICH.) BAAGOE, loc. cit. (1974), **synon. nov.** Type: Ethiopia, near Adwa, SCHIMPER 401 (TUB lecto.; BM!, K! W!).

Sigesbeckia somalensis S. MOORE, J. Linn. Soc. Bot. 35: 342 (1902), **synon. nov.** Type: Somalia, Sheik Mahomet, 30 Oct. 1894, DONALDSON-SMITH 226 (BM! holo.).

The achenes and corolla of *S. somalensis* are typical of *G. schimperi.*

2. **Aspilia** THOUARS

Aspilia was recently "formally merged" with *Wedelia* JACQ., by ROBINSON (1992). He did this based on the description of the type genus, *A. thouarsii* A. DC. (1836) from Madagascar, given by HUMBERT (1963).

In a cladistic analysis of morphological features, KARIS (1993) found that *Wedelia* and *Aspilia* are sister taxa. In *Wedelia,* he included only American taxa. Elaiosomes, characteristic of the achene bases of *Wedelia, Aspilia* and *Exomiocarpon* LAWALREE, were among the characters used in the analysis. *Exomiocarpon* is an endemic genus to Madagascar diagnosed by 1-5, neuter ray florets and kidney-shaped elaiosomes (BREMER1994). BREMER (op. cit., p. 572) accepted the inclusion of *Aspilia* in *Wedelia* but retained *Exomiocarpon.* Others working on the flora of the Americas have also accepted this treatment (cf. TURNER 1992). Prior to this, STROTHER (1991), working on the North American species of *Aspilia* and *Wedelia,* and MCVAUGH (1984), on the flora of part of Mexico, expressed difficulties in separating the American species of

Aspilia from *Wedelia*. Consequently, STROTHER (op. cit.) included all the American species of *Aspilia* in *Wedelia*. About the African species, he wrote "some, perhaps all, African species named in *Aspilia,* may belong within my circumscription of *Wedelia*". TURNER (op. cit.) transferred the South American species of *Aspilia* to *Wedelia* and regarding the African species, he wrote that the transfer "... should be left to a worker specializing on that region".

On the question of the identity of this two genera, WILD (1965), working on the Flora Zambesiaca area, wrote, "the only genuine species of *Wedelia* occurring in Africa is considered to be *Wedelia trilobata* ..." and kept *Aspilia* as an African/Madagascan genus. Recently, *Wedelia trilobata* (L.) A. HITCH. was removed from *Wedelia* and made the type of *Complaya* STROTHER (1991). Other western hemisphere genera of *Heliantheae* which are represented either by ornamental plants or by various introductions in Africa are *Cosmos* CAV., *Coreopsis* L., *Glossocardia* CASS., *Chrysanthellum* RICH., *Helianthus* L., etc.

Aspilia and *Wedelia* share a number of features, some of which are extremely variable even within a species, e.g., colour of anther appendages. Traditionally *Wedelia* has been distinguished from *Aspilia* by its pistillate and fertile ray florets, obtusely angled achenes, and cup-shaped (coroniform) awnless or short-awned achenes (BENTHAM 1873). This distinction was, however, abondoned by African synantherologists, e.g. ADAMS (1963), WILD (1965). Currently it is believed that there are "solid differences" between *Aspilia* and *Wedelia,* especially in such characters as number of series in the involucre (only 2 in *Wedelia*, more in *Aspilia* with the outer series being foliaceous), anther cylinder (black in *Aspilia*), achene morphology, etc. (N. HIND, G. POPE and H. BEENTJE at Kew, pers. comm.).

The present author agrees with the view that the genera should be kept separate until the type specimen (if extant) is examined or material from the type locality is collected and further studied. Besides, *Aspilia* in Africa has also been confused with another African genus, *Guizotia.* The sexual condition of the ray florets (pistillate versus neuter), which is variable in many genera of the *Compositae*, should not continually be employed as the main criterion of distinction between *Aspilia* and *Wedelia.* Consequently, the following synonymy is established within *Aspilia.*

Aspilia africana (PERS.) ADAMS subsp. ***magnifica*** (CHIOV.) WILD, Kirkia 6: (1966).

Aspilia congoensis S. MOORE, Journ. Bot. 58: 45 (1920), **synon. nov.** Type: Zaire, upper Uili, LACOMBLEY 67 (BM holo.).

Aspilia africana is a widespread species in Africa and it exhibits wide variation in foliar and capitular features. Populations from West Africa (*A. africana* subsp.

africana) have smaller capitula and their paleae are often obtuse or acute; however, some material, e. g., JEFFREY 321 from Gabon, has long acuminate paleae, while MORTON 6642 and 8052 (from Ghana) have shortly caudate-acuminate paleae. So far, *A. africana* subsp. *magnifica* is known from Sudan, Ethiopia, Uganda, Zaire and Angola.

3. Bidens L.

Bidens kirkii (OLIV. & HIERN) SHERFF, Bot. Gaz. 59: 309 (1915).

Coreopsis curtisii SHERFF, Bot. Gaz. 96: 146 (1934), **synon. nov.** Type: A cultivated plant grown from seeds obtained from Angola by RICHARD C. CURTIS (F, holotype!).

Previously (MESFIN 1993), *C. curtisii* was kept as an imperfectly known species and it was referred, following the description provided by SHERFF (1936), to *B. oligoflora* (KLATT) WILD. The type of *C. curtisii* was recently examined and it clearly belongs to *B. kirkii.*

Inuleae

1. *Blumea* DC.

Blumea dregeanoides SCH. BIP. ex A. RICH., Tent. Fl. Abyss., vol.1, p. 392 (1848). Type: Ethiopia, near Ferrokoba, SCHIMPER 633 (P syn., K! isosyn.), Wogera, Schimper 1297 (P syn., S! isosyn.); Chire, QUARTIN-DILLON s.n. (P syn.); Choa, PETIT s.n. (P syn., K! isosyn.).

Blumea molllis (D. DON) MERR. (1910), **synon. nov.** Type: Nepal, WALLICH s.n. (BM holo).

Lactuceae

1. Dianthoseris SCH. BIP. ex A. RICH.

Dianthoseris schimperi SCH. BIP. ex A. RICH., Tent. Fl. Abyss., vol.1, p. 468 (1848).

Nannoseris inopinata CUFOD., Stuttg. Beitr. Natur. 195: 7 (1968), **synon. nov.** Type: Ethiopia, Amba Ras & Buahit, 3600 m, 9 Nov. 1966, SEBALD 1046 (STU, holotype!).

Nannoseris inopinata was differentiated from *D. schimperi* (sub *N. schimperi)* based on leaf size and features of the margins, involucre size and pubescence, receptacle pubescence, ligule-tube ratio of the ligulate florets and the pappus, which was given

as 10 mm long. As provided, it falls within the range of variation of *D. schimperi*. Examination of the typer revealed no other distinctive features either.

Selected specimens: Ehtiopia: Gonder, Semien, Geech, 15 Oct. 1973, HEDBERG & G. AWEKE 5360 (ETH, K. UPS). Mt. Buahit, SCHIMPER 755 (BM, K). Bale, Sanetti, 2 Nov. 1984, FRIIS et al. 3715 (ETH, K, UPS). Gojam, Choke mts., Mt. Birhan, 28 Aug. 1957, EVANS & HILLIER 335 (BM, K). Note: Leaves in HEDBERG & G. AWEKE 5360 are pinnatilobed. The inner pappus are c. 10 mm long.

Senecioneae

1. *Senecio* L.

Senecio schultzii HOCHST. ex A. RICH., Tent. Fl. Abyss., vol. 1, p. 444 (1848).

This species is endemic to high mountains in Ethiopia. Two forms, recognizable only by the degree of pubescence of the leaves and phyllaries, are known from about the same mountain massif in southern Ethiopia. Until a better evidence that suggests otherwise is obtained, these are recognized here as varieties of the same species and they can be differentiated as follows:

Leaves, stems and phyllaries sparsely to densely pubescent ..... 1. var *schultzii*

Leaves, stems and phyllaries thinly to densely white tomentose to woolly .... 2. var. *lanatus*

1. var. ***schultzii***

Type: Ethiopia, Buahit, SCHIMPER 1278 (P holotype; BM!, LE!, K! isotypes).

This variety is known from afro-alpine meadows and *Erica arborea* scrub at altitudes between 3270 m and 4050 m from Gondo (GD), Gojam (GJ), Wello (WU), Shewa (SU), Arssi (AR), Bale (BA) and Gamo Gofa (GG) regions in Ethiopia.

Selected specimens: Ethiopia: Gonder, Sermien, 19 Oct. 1973, HEDBERG & G. AWEKE 5488 (ETH, K, UPS). Gojam, Mt. Birhan, 21 Aug. 1957, EVANS & HILLIER 556 (BM, K). Shewa, Ankober, 26 June 1971, ASH 1017 (K) . Arsi, Mt. Chilalo, 21 Dec. 1953, MOONEY 5199 (ETH, K); Mt. Cacca, 25 Dec. 1953, MOONEY 5286 (ETH, K). Bale, 31 km on Goba-Dello Mena Road, FRIIS et al. 3401 (ETH, K). Gamo Gofa, Gughe highlands, Mt. Yola, 15 Dec. 1948, SCOTT 138 (K).

2. var. ***lanatus*** OTIENO & MESFIN, **var. nov.**, a var. *schultzii* foliis et phyllariis albido tomentosis differt. Typus: Ethiopia, Bale, Batu, 4150 m, 17 Dec. 1959, MOONEY 8332 (ETH, holotype; K isotype).

S. schultzii var. A sensu Otieno & Mesfin, Comp. Newsl. 20/21: 24 (1992).

This variety is similar to var. *schultzii* except for the dense or matted white or silvery hairs on the leaves and often also on the peduncles and phyllaries. It is so far known only from Afro-alpine meadows in the Bale Mountains at altitudes between 3900 m and 4375 m.

Selected specimens: Ethiopia: Bale, Tullu Deemtu, 1 Nov. 1973, Hedberg 5616 (ETH, K, UPS); 31 km on Goba-Dello Menna road, 24 Oct. 1984, Friis et al. 3409 and 3412 (ETH, K, UPS); Sannetti plateau and Mount Batu, 8 Nov. 1982, Anderberg 1695 (ETH); 29 Sept. 1982, Puff, Ensermu, Dawe & Edwards 820929-1/7 (ETH); Tullu Deemtu, 8 June 1986, Mesfin T. 4378 and 4406 (ETH). Note: Mooney 8322A was collected from Bale, Sanetti plateau, at 4150 m, probably the same location as Mooney 8332, but it belongs to var. *schultzii.*

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A study of *Vernonia coerulea* KOSTER in Sumba Island, Indonesia

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Abstract

Vernonia coerulea KOSTER (Compositae) is an endemic species in Sumba Island, East Nusa Tenggara. The characteristics, habitat and potential of this species were recorded on a botanical expedition to Luku Melolo forest, Sumba, in 1997-1998. It was found that *V. coerulea* grows well only in a limited area. The major threats to the species are competition with many introduced species and human activities.

Introduction

Vernonia (Compositae, tribe Vernonieae) is a large and heterogeneous genus which includes herbs, shrubs, trees and vines. Despite its worldwide distribution and large number of species (possibly 500, cf. BREMER 1994, KEELEY & TURNER 1990) *Vernonia* is still a poorly known genus. Several species are distributed in the Indonesian archipelago and some of them are endemic. *Vernonia coerulea* is one of these, being endemic to Sumba Island, East Nusa Tenggara.

Vernonia coerulea is a species neglected by botanists and horticulturists. KOSTER (1935) described the species, but provided only very limited information. The species grows only in Sumba island which has some different characteristics of habitat compared to other islands in Indonesia. The aim of the expedition was to collect detailed information on its habitat and potential, and to find out the solution for its conservation.

Methods

The investigatons were conducted at Luku Melolo Forest Protection, Sumba Island, in November 1997 and May 1998.

Interview with indigenous people was undertaken for collecting information of habitat and possible role in their social life. Some plots were made in the forest area to measure the range of ecological factors and inventory the associated species.

Herbarium material was also examined including dissection of material under a binocular microscope.

Results

A. Description

Shrub or small tree, 1–2 m high with strong adventitious roots. Stem terete, 0.5–2 cm in diameter, with greenish white hard wood; old bark brown, thin with rough dots and sears of broken branches, young bark soft green, with grooves. Leaves spiral, alternate, simple, sessile-subsessile, rhomboid-elliptic–lanceolate or oblanceolate, 2–11 cm x 0.8–3.2 cm, pale green, apex acute; base attenuate; margin undulate to crenate. Inflorescences terminal or axillary, corymbose; capitulum discoid, phyllaries 3-seriate, green; pedicels 1–10 mm; young disc-florets white becoming blue or violet; corolla tube 3 mm, 5-lobed, glabrous; anther-base sagittate, apex obtuse, filament 2–3 mm; style arms filiform, 0.5–1 mm; pappus barbellate, white, 3–5 mm; achene cylindrical, black, 1–2 mm, with a glandular carpopodium at the base.

B. Ecological Data

Association species of *Vernonia coerulea* in Luku Melolo Forest

Stratum	Species	Freq.	Cover area (%)
A (Ground cover)	*Flemingia strobilifera*	0.40	5-25
	Hyptis pectinata	0.10	3
	Cassia pumila	0.10	5
	Euphorbia prostrata	0.10	5
	Indigofera trifoliata	0.20	1
	Oxalis corniculata	0.10	15
	Phyllanthus sp.	0.10	1
	Urena lobata	0.10	50
	Heteropogon sp.	0.10	10
B (high < 1m)	*Glochidion rubrum*	0.10	15
	Ficus septica	0.10	5
	Desmodium gangeticum	0.10	5
	Elephantopus scaber	0.10	5
	Eupatorium riparium	0.10	5
	Nauclea sp.	0.20	5-10
	Pteris exaltata	0.10	10
C (high > 1 m)	*Stachytarpheta cayennensis*	0.40	25-50
	Eupatorium odoratum	0.70	25-50
	Imperata cylindrica	0.60	2-50
	Strobilanthes sp.	0.10	10
	Miscocarpus pentapetalus	0.10	5
	Ventilago microcarpa	0.10	5
	Micromelum minutum	0.10	5
	Lagerstroemia sp.	0.30	15-25
	Lantana camara	0.20	5-10

Based on Law of Frequency, the vegetation is **Normal Distribution** (MISRA 1980).

Abiotic Factors of *Vernonia coerulea*

Factor	Range
Temperature	28° - 30° C
pH	6.9 - 7.5
RH	60 - 75 %
Altitude	450 - 525 m asl
Light	50 - 100 %

C. Ethnobotanical data

Indigenous people of Luku Melolo commonly use leaves of 'tandai lapua' (*Vernonia coerulea*) for curing of the tropical thrush and cough. The preparation is the following: The leaves are crashed and chewed for a few minutes or the leaves are squeezed to a drink (± 1 tea spoon); the taste is rather bitter, so overdoze is avoided.

Discussion

Vernonia coerulea is an important narrowly endemic species in biodiversity and taxonomy, and because of its beautiful flower it has a potential as an ornamental plant. The leaves are useful for medical treatment, especially herbal medicine for tropical thrush.

Like many other Compositae, *Vernonia coerulea* grows well in open areas. However, it needs special habitats for supporting its normal growth. It grows better in bushland than in grasslands or dense rain forests. It grows mainly as single individuals on lime stone areas with bushland. The plants may reach 2 m in height and produce many regular branches under suitable conditions, especially in areas with thin manure and less water content of soil.

Chromolaena odorata and *Stachytarpheta cayennensis* are found as main competitors of *V. coerulea*. This is clearly observed on the growth of these three species in the rainy season. *V. coerulea* grows well only in areas where the two other species do not occur. It is also found in grassland areas particularly under shady plants like *Schleichera oleosa* and *Timonius flavescens*. In such areas *Ageratum conyzoides* is another

competitor to young plants of *V. coerulea.*It is rarely found in the mixed rain forest.

Conclusion

Development of the uses of *V. coerulea* is needed. Conservation of this species could be done by alternative developments such as living fences and using it for revegetation.

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Fig. 1. ***Vernonia coerulea*** **KOSTER**

New records of *Fulcaldea* (Compositae-Barnadesieae) and the importance of local herbaria for floristic inventory in the tropics

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Abstract

Several new collection records of *Fulcaldea laurifolia* from Ecuador and Peru are presented, showing that the species, and thus the genus, is less rare than previously thought. The study also implies that small local herbaria may play an important role in the exploration of tropical floras.

Introduction

The genus *Fulcaldea* Poir. consists of a single, highly characteristic species, *F. laurifolia* (H. & B.) Poir. ex Less., endemic to the dry zones of western and southern Ecuador and northern Peru (Harling 1991, Brako & Zarucchi 1993). The species forms small, evergreen trees with a well demarcated trunk, a much-branched crown, and coriaceous, 3-veined leaves. The capitula are single-flowered and arranged in dense synflorescences at the end of the branches (Fig. 1). The pappus bristles, which are longer than the corolla, are plumose and have a pale pinkish tinge, giving the synflorescences and indeed the whole flowering tree a pinkish tinge.

Fulcaldea is probably most closely related to *Barnadesia*, a mainly Andean genus of some 25 species. It differs from that genus by its single-flowered capitula and by having the style distinctly swollen below the lobes (Fig. 2), two features unique in the subfamily Barnadesioideae (Bremer 1994). According to Bremer (1994), *Fulcaldea* differs also from *Barnadesia* in having ecaudate anthers (vs. caudate), endothecial tissue with radial thickenings (vs. without thickenings), and in pollen morphology.

For his treatment of *Fulcaldea* for Flora of Ecuador, Harling (1991) only saw three collections, i.e. the type collected by Humboldt and Bonpland in the Loja Province in 1802, and two collections from the coastal province of Manabí made in 1893 and 1955. Because of this, Harling stated that "*Fulcaldea laurifolia* is apparently a rare species". Recent field work has revealed that *F. laurifolia* occurs in great numbers at certain localities, both in the Loja Province (pers. obs.) and in the Machalilla Reserve (C. Josse, pers. com.) in the province of Manabí.

Distribution and ecology

Fulcaldea laurifolia is distributed (Fig. 3) in the coastal lowlands of the Manabí Province (50—150 m alt.) and in the uplands of southern Ecuador and northern Peru (650—1850 m alt.). It grows in dry deciduous forests, but at most localities these forests are now degraded because of logging and grazing, the latter mainly by goats and donkeys.

Despite the difference in altitude the disjunct distribution is not unexpected considering the climatic similarity of these two areas. Furthermore, there are many other woody plants occurring in both areas (e.g. *Achatocarpus pubescens*, *Bursera graveolens*, *Ceiba trischistandra*, *Cordia lutea*), although most of these have much larger total distributions.

The species flowers from March through September, typically the driest period of the year.

Collections of *Fulcaldea*

ECUADOR. **Manabí**: Jama, 5 km from Pedernales, 50 m, 80°14'W, 00°10'S, Cornejo s.n. (GUAY). El Recreo, 80°27'W, 00°29'N, 1897, Eggers 14944 (GB, K). San Vicente, 1935, Asplund 16595 (K, S). Machalilla National Park, Río Piñas, 80° 41' W, 1° 39' S, 150 m, 28 Jul 1994, Josse 1063 (AAU, GB). **Loja**: 3-6 km N of Sozoranga on road to Tumbanuma, southern slope above Suquinda stream, 79°47'W, 4°19'S, 1600-1700 m, 18 Sep 1989, Munday & Maldonado 001 (QCNE). 5 km from Catacocha on road to San Vicente, 79°39'W, 4°6'S, 2000 m, 26 July 1990, Jørgensen et al. 92152 (AAU). 5 km from Catacocha on road to Loma Quemada, 79°36'312"W, 4°6'95"S, 1600 m, 16 Apr 1996, Lewis et al. 2247 (AAU, K, LOJA, QCA, QCNE). Sozoranga outskirts, 1 km along track to Utuaña, 79°47'W, 4°20'S, 1700 m, 5 Mar 1997, Lewis & Lozano 3038 (AAU, K, LOJA, QCNE). Km 2 on road Sozoranga-Yaramine, 1750 m, 79°48'W, 4°18'S, 14 June 1997, Klitgaard, Ståhl et al. 203 (AAU, LOJA, K). Sozoranga, km 4 along track from Sozoranga-Macará road to the El Tundo Reserve, 1850 m, 79°49'W, 4°19'S, 19 Aug 1997, Lewis et al. 3497 (AAU, K, LOJA, QCA, QCNE). Near Sozoranga on road to Suquinda, 1500 m, 79°48'W, 4°22'S, Lozano et al. 299 (LOJA). Yamana, 79°40'W, 3°59'S, Aug 1976, Vivar 871 (LOJA). La Vega Grande, 79°32'25"W, 4°5'16"S, 27 May 1982, Vivar 1568 (LOJA).

PERU. **Piura**: Prov. Ayabaca, 18 km above Puente Tandopa (Río Quiroz) on road to Ayabaca, 1700 m, 24 Sep 1964, Hutchison & Wright 6685 (K, NY). Prov. Huancabamba, La Afiladera, 650 m, 12 Sep 1981, Lopez & Sagastegui 8774 (NY).

Vernacular names and uses

The common name for this species in the Loja province is "guayache" ("guallache"), whereas on the coast it is known under the name of "sobretana". The wood is strong and in southern Ecuador the species is used in house construction, especially as roof support, and as fence posts.

Remarks

The present investigation shows that *Fulcaldea laurifolia* is less rare than was previously thought. In fact, it is locally abundant, both near Sozoranga and in the Machalilla Reserve, and is at certain places one of the most common woody species.

The results also have some important implications for tropical floristic inventory in general. Firstly, the importance of local herbaria and locally based collection programmes cannot be underestimated. The LOJA herbarium has grown and developed considerably during the last 10 years and is now a very important resource for botanical investigations in southern Ecuador. The same can be said about the small but quickly growing herbarium in Guayaquil (GUAY), which now houses important collections from the Ecuadorian coast. Secondly, the flowering period of *Fulcaldea laurifolia*, March through September, is no doubt undercollected in general. Most older collections have been made by European and North American botanists visiting the tropics in the northern hemisphere winter time. Local collection programmes unbiased by "winter vacations" will certainly reveal many new records in the future.

Acknowledgement

We thank CARMEN JOSSE for providing information on *Fulcaldea* in the Machalilla Reserve.

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Fig. 1. *Fulcaldea laurifolia.*

A habit, flowering branch (× 1/6, LEWIS et al. 3497);
B stem with spines (× 1/3, VIVAR 1568). Del. G. LEWIS.

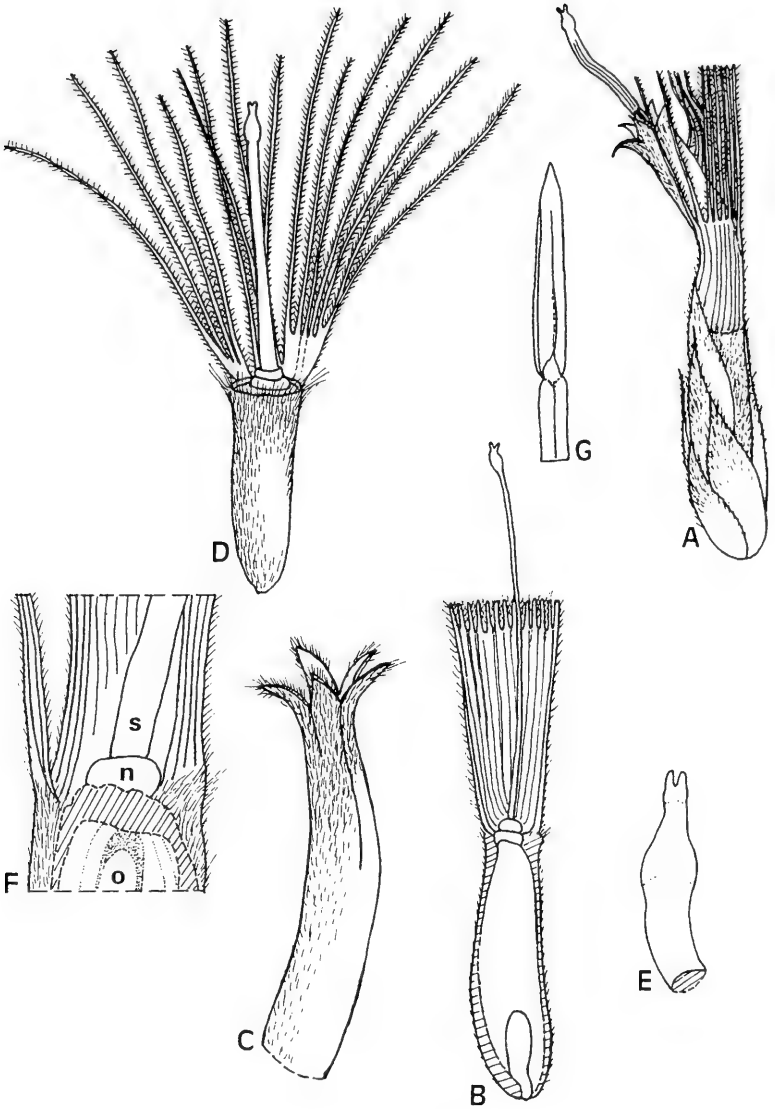

Fig. 2. *Fulcaldea laurifolia.*

A single flower (× 2); B longitudinal section of ovary and pappus (× 2.5); C corolla (× 3.25); D developing achene and pappus (× 2); E style tip and stigma (× 10); F longitudinal section of achene apex (× 8.5; o = ovary, n = nectary, s = style); G anther (× 7). (Lewis et al. 3497). Del. G. Lewis.

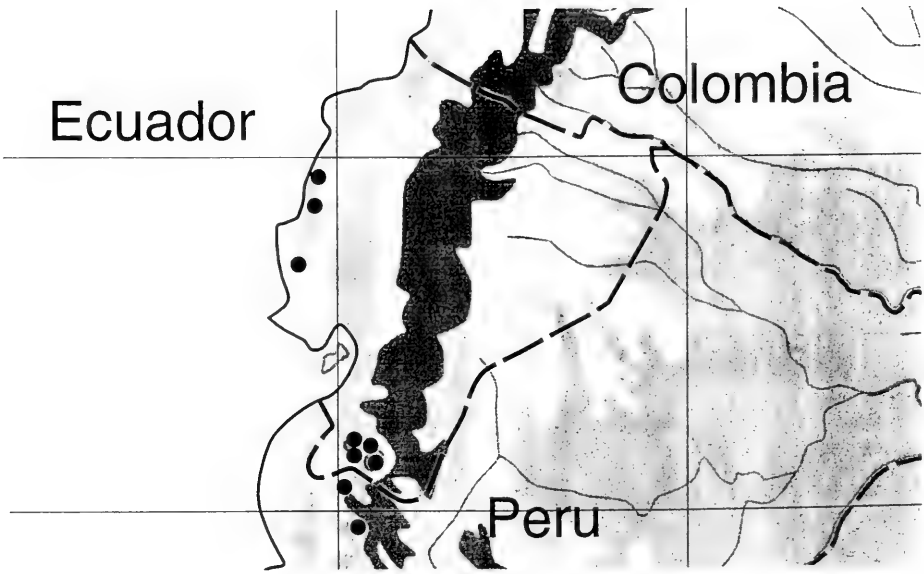

Fig. 3. Distribution of *Fulcaldea laurifolia.*

The family Asteraceae in the Chhindwara District of Madhya Pradesh, India

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Abstract

The present paper enumerates 57 species belonging to 43 genera of the Asteraceae family occurring in Chhindwara District of Madhya Pradesh. *Parthenium* is found to be the dominant genus because of one obnoxious weedy species, while *Blumea* is represented by the maximum number of species. On the other hand, *Sigesbeckia* was recorded from Tamia only. Many species of Asteraceae are used in medicine, including several species mentioned here.

Introduction

Asteraceae is one of the largest families of vascular plants with almost 25,000 species and over 1500 genera. The family is well represented in tropical and subtropical regions of the world. In India, there are 1052 species under 177 genera (Rao et al. 1988). They are distributed along river banks, sea coasts, cultivated fields and also in alpine regions of the Himalayas. Commercially, the family is important as some plants like sunflower and safflower are the source of oil, many of them are useful in medicine, and some of them are ornamental.

To date, there is no published record of Asteraceae flora form Chhindwara. Therefore, it was felt desirable to carry out an extensive survey of the plants of this family in this region. Periodical surveys for collection of Asteraceous plants were made during

1997 to 1998. The vouchers of specimens have been deposited in the Department of Botany of Danielson College.

Areas and Methods

The areas of the district Chhindwara that have been explored include: Pataalkot, Tamia, Junnardeo, Damua, Parasia, Bhanadehi, Atarwada, Pandurna, Sausar, Ramakona, Sillewani-Ghats, Chhindi, Kukrakhapa, Bhartadeo, Rohna, Chhindwara, Karaboh-Dam, etc. Besides, regions which are out of the district but are situated in suburbs of Chhindwara were also explored. These are Saoner (Maharastra), Chhapara, Matkuli and Pachmarhi. It was found that a number of species exist here, some of which have been identified and included in the present communication, while others are still in the process of identification.

The list of the plants is presented in alphabetical order. The accepted name of the species is followed by flowering and fruiting period (Fl & Fr), and the nomenclature has been updated according to Bennet (1987). Comments on distribution and weediness are also given.

Systematic Enumeration

1. ***Acanthospermum hispidum*** DC., Prodr. 5: 522, 1836; R. R. Rao et al., Fl. Ind. Enum. Aster. 1, 1988.

Fl & Fr: Jul/Oct

Distribution: Widely distributed in Chhindwara, Bhartadeo, Chandangaon, Imlikheda, Umaranala, Sillewani-Ghat, Parasia, Atarwada, Tamia, Junnardeo, Bhanadehi, etc.

2. ***Ageratum conyzoides*** L., Sp. Pl. 839, 1753; Hook. f., Fl. Brit. India 3: 243,1881.

Fl & Fr: May/Dec

Distribution: Throughout Chhindwara Dist. viz., Chandagaon, Badwan, Kundipura, Kukda, Bhanadehi, Atarwada, Parasia, Tamia, etc., particularly on wasteland.

3. ***Amberboa ramosa*** (Roxb.) Jofri in Scientist 3: 29, 1959. *Carduus ramosus* Roxb., Hort Bengal. 101, 1814; Fl. Ind. ed. 2, 3: 407, 1832.

Fl & Fr: Jul/Feb

Distribution: Occurs as a weed in cultivated fields and wastelands in Bhanadehi,

Tamia, Patalkot, Karaboh.

4. ***Bidens biternata*** (Lour.) Merr. & Sherrf in Bot. Gaz. 88: 293, 1929. *Coreopsis biternata* Lour., Fl. Cochinch. 508, 1708. *Bidens pilosa* auct. non L.; Hook. f., Fl. Brit. India 3: 309, 1881.

   Fl & Fr: Aug/Jan

Distribution: Common as a weed in wastelands of Chandangaon, Parasia, Jamai, and Chhindwara proper etc.

5. ***Blainvillea acmella*** (L.) Philipson in Blumea 6: 350, 1950. *Verbesina acmella* L., Sp. Pl. 901, 1753. *Blainvillea latifolia* (L. f.) DC. ex Wight, Contr. Bot. Ind. 71, 1834; Hook. f., Fl. Brit. India 3: 305, 1881.

   Fl & Fr: Apr/Nov

Distribution: Chhindwara, Bhartadeo, Chandangaon, Tamia, Patalkot.

6. ***Blumea balsamifera*** (L.). DC., Prodr. 5: 447, 1836; Hook. f., Fl. Brit. India 3: 270, 1881. *Conyza balsamifera* L., Sp. Pl. ed. 2: 1208, 1763.

   Fl & Fr: Nov/Apr

Distribution: Badwan, Bhanadehi, Khajri, Chhindwara.

7. ***B. eriantha*** DC. in Wight, Contr. Bot. India 15, 1834; Hook. f., Fl. Brit. India 3: 266, 1881.

   Fl & Fr: Nov/Apr

Distribution: Danielson College Campus, Tamia, Patalkot and Sillewani-Ghats.

8. ***B. lacera*** (Burm. f.) DC. in Wight, Contr. Bot. India 14, 1834; Hook. f., Fl. Brit. India 3: 263, 1881. *Conyza lacera* Burm f., Fl. Ind. 180. t. 49. f. 1, 1768. *B. subcapitata* DC., Prodr. 5: 439, 1836. *B. lacera* DC. var. *cinerascens* Hook. f., Fl. Brit. India 3: 263, 1881. *B. lacera* var. *glandulosa* Hook. f., Fl. Brit. India 3: 263, 1881.

   Fl & Fr: Jan/Jun

Distribution: Bhartadeo, Tamia, Dharamtekri, Bhanadehi and other parts of Chhindwara Dist.

9. ***B. laciniata*** (Roxb.) DC., Prodr. 5: 436, 1836. Hook. f., Fl. Brit. India 3: 264, 1881. *Conyza laciniata* Roxb., Fl. Ind. 3: 428, 1832.

   Fl & Fr: Dec/Mar

Distribution: Chhindwara, Tamia, Patalkot.

10. ***B. mollis*** (D. Don) Merr. in Philipp. J. Sci. (Bot.) 5: 395, 1910. *Erigeron molle* D. Don, Prodr. Fl. Nepal 192, 1825. *B. wightiana* DC. in Wight, Contr. Bot. Ind. 14, 1834. *B. neilgherrensis* Hook. f., Fl. Brit. India 3: 261, 1881.

    Fl & Fr: Feb/May

Distribution: Chhindwara, Chandangaon, Umaranala, Parasia, Tamia.

11. ***Caesulia axillaris*** Roxb., Pl. Corom. 1: 64. t. 93, 1798; Hook. f., Fl. Brit. India 3: 291, 1881.

    Fl & Fr: Oct/Nov-Apr

Distribution: It is a semi-aquatic herb distributed in Chhindwara, Parasia, Atarwada, Bhanadehi, Badwan, Umaranala, Mohked, Chourai, Kanhargaon Dam.

12. ***Carthamus tinctorius*** L., Sp. Pl. 830, 1753; Hook. f., Fl. Brit. India 3: 386, 1881.

    Fl & Fr: Feb/Apr

Distribution: Cultivated for oil in Chandangaon, Khajri, Jamai, Amarwada, Pandurna.

13. ***Centipeda minima*** (L.) A. Br. & Aschers., Ind. Sem. Fl. Berol. App. 6, 1867. *Artemisia minima* L., Sp. Pl. 849, 1753. *Centipeda orbicularis* Lour., Fl. Cochinch. 493, 1790; Hook. f., Fl. Brit. India 3: 317, 1881.

    Fl & Fr: Throughout the year

Distribution: Tamia, Sidhauli, Gailadubba, Patalkot.

14. ***Chrysanthemum indicum*** L., Sp. Pl. 889, 1753. Bailey, Man. Cult. Pl. 989,1949.

    Fl & Fr: Oct/Dec

Distribution: Chhindwara, Tamia, Parasia, Pandurna, Sausar.

15. ***Cichorium intybus*** L., Sp. Pl. 813, 1753; Hook. f., Fl. Brit. India 3: 391,1881.

    Fl & Fr: Jan/Jun

Distribution: Chandangaon, Chhindwara, Amarwada, Khirsadoh.

16. ***Cosmos bipinnatus*** Cav., Icon. 1: 10. t. 14, 1791; Cooke, Fl. Pres. Bombay 2: 125, 1904-08 (BSI reprint, 1958).

    Fl & Fr: Aug/Nov

Distribution: Chhindwara, Parasia, Sillewani Ghats, Chand, Chandangaon, Bhartadeo.

17. ***C. sulphureus*** Cav., Icon. 1: 56. t. 79, 1791.

    Fl & Fr: Sep/Jan

Distribution: Chhindwara, Bhartadeo, Parasia, Hirdagarh, Sausar, Bhanadehi.

18. ***Cyathocline purpurea*** (Buch.-Ham. ex D. Don) O. Kuntze, Rev. Gen. Pl. 333, 1891. *Tanacetum purpureum* Buch.-Ham. ex D. Don, Prodr. Fl. Nepal.181, 1825. *Cyathocline lyrata* Cass. in Ann. Sci. Nat. Ser. 1, 17: 420, 1829; Hook. f., Fl. Brit. India 3: 246, 1881. *Dichrocephala minutifolia* Vaniot in Bull. Acad. Internat. Geogr. Bot. 12: 243, 1903.

    Fl & Fr: Dec/May

Distribution: Chhindwara, Bhanadehi, Tamia.

19. ***Dahlia pinnata*** Cav., Icon. 1: 57. t. 80, 1791.

    Fl & Fr: Jun/Dec

Distribution: Chhindwara, Parasia, Pandurna, Harrai.

20. ***Echinops echinatus*** Roxb., Hort. Beng. 62, 1814, Fl. Ind. 3: 447, 1832; Hook. f., Fl. Brit. India 3: 358, 1881.

    Fl & Fr: Oct/May

Distribution: Chhindwara, Bhanadehi, Bhartadeo.

21. ***Eclipta alba*** (L.) Hassk., Pl. Jav. Rar. 528, 1848; Hook. f., Fl. Brit. India 3: 304, 1881.

    Fl & Fr: Jun/Mar

Distribution: Almost in all parts of Chhindwara Dist. viz., Amarwada, Chhindwara, Chourai, Jamai, Chand, Bhanadehi etc.

22. ***E. prostrata*** (L.) L., Mant. Pl. 2: 286, 1771. *Verbesina prostrata* L., Sp. Pl. 902, 1753. *Eclipta alba* (L.) Hassk., Pl. Jav. Rar. 528, 1848; Hook. f., Fl. Brit. India 3: 304, 1881.

    Fl & Fr: Almost throughout the year

Distribution: In moist or aquatic regions of Chhindwara Distr, viz., Bhartadeo, Tamia, Kukrikhapa, Chhindwara.

23. ***Elephantopus scaber*** L., Sp. Pl. 814, 1753; Hook. f., Fl. Brit. India 3: 242, 1881.

Fl & Fr: Oct/May

Distribution: Occurs on shady places particularly under trees. Distributed in Bhartadeo, Tamia, Dharam tekri.

24. ***Emilia sonchifolia*** (L.) DC. in WIGHT, Contr. Bot. Ind. 24, 1834. *Cacalia sonchifolia* L., Sp. Pl. 835, 1753; HOOK. F., Fl. Brit. India 3: 336, 1881.

Fl & Fr: Throughout the year

Distribution: Chhindwara, Bhartadeo, Guraiya, Rohna, Shikarpur, Tamia, Shivpuri.

25. ***Erigeron asteroides*** ROXB., Hort. Beng. 61, 1814, Fl. Ind. ed. 2, 3: 432, 1832 non ANDRZ. ex BESS., Enum. Pl. 33, 1821; HOOK. F., Fl. Brit. India 3: 254, 1881.

Fl & Fr: Dec/May

Distribution: Tamia, Patalkot, Bhartadeo.

26. ***Eupatorium triplinerve*** VAHL, Symb. Bot. 3: 97, 1794. *E. ayapana* VENT., Jard. Malm. 3. t. 3, 1804; HOOK. F., Fl. Brit. India 3: 244, 1881.

Fl & Fr: Sep/Jan

Distribution: Ornamental. Distributed in Chhindwara, Tamia, Sausar, Karaboh Dam.

27. ***Gaillardia pulchella*** FOUG., Mem. Acad. Sci. Paris. 1786, 5. t. 1, 1788; MATTHEW, Fl. Tamil-Carnatic 3: 790, 1984. *G. bicolor* LAM., Encycl. 2: 590, 1788.

Fl & Fr: Mar/Sep

Distribution: Ornamental. Distributed in Chhindwara, Tamia, Jam, Bhartadeo.

28. ***Galinsoga parviflora*** CAV., Icon. 3: 41. t. 281, 1795; HOOK. F., Fl. Brit. India 3: 311, 1881.

Fl & Fr: Dec/Apr

Distribution: It is an obnoxious weed. Grows in cultivated fields: Bharatadeo, Bhanadehi, Pandurna, Tamia, Chhindwara.

29. ***Gnaphalium luteo-album*** L., Sp. Pl. 851, 1753; HOOK. F., Fl. Brit. India 3: 288, 1881. *G. luteo-album* L. subsp. *pallidum* (LAM.) MAHESHW. in J. Bombay Nat. Hist. Soc. 57 (2): 377, 1960.

Fl & Fr: Throughout the year

Distribution: Danielson College Garden, Badwan, Kukda, Tamia, Patalkot, Linga, Parasia.

30. ***G. pensylvanicum*** WILLD., Enum. Hort. Berol. 867, 1809. *G. peregrinum* FERNALD in Rhodora 45: 479, 1943. *G. purpureum* auct. non L.; HOOK. F. , Fl. Brit. India 3: 289, 1881.

    Fl & Fr: Jan/Nov

Distribution: In the sandy soil of Chhindwara, Chourai, Tamia, Umaranala. Harrai, Shikarpur.

31. ***G. purpureum*** auct. non L., Sp. Pl. 854, 1753; HOOK. F., Fl. Brit. India 3: 289, 1881.

    Fl & Fr: Aug/May

Distribution: In open dry places in Chandangaon, Kundipura, Umreth, and Pandurna.

32. ***Guizotia abyssinica*** (L.F.) CASS. in Dict. Sci. Nat. 59, 248, 1829. *Polymnia abyssinica* L. F., Suppl. 383, 1782. *Verbesina sativa* ROXB. ex SIMS in Bot. Mag. 26. t. 1017, 1807; HOOK. F., Fl. Brit. India 3: 308, 1881.

    Fl & Fr: Sep/Dec

Distribution: Cultivated in Chourai, Amarwada, Chhindwara, Bhanadehi, Atarwada and various parts of Chhindwara District for extraction of "JAGNI" oil.

33. ***Gynura nitida*** DC. in WIGHT, Contr. Bot. Ind. 24, 1834; HOOK. F., Fl. Brit. India 3: 333, 1881.

    Fl & Fr: Dec/May

Distribution: Danielson College Garden, Tamia, Patalkot, Jam, Bicchua.

34. ***Helianthus annuus*** L., Sp. Pl. 904, 1753; R. R. RAO et al., Fl. Ind. Enum. Asterac. 43, 1988.

    Fl & Fr: Oct/Dec

Distribution: Cultivated for edible oil in all parts of Chhindwara Dist. viz., Amarwada, Atarwada, Chandangaon, Bhanadehi, Jam, Junnardeo, Linga, Chhindwara.

35. ***Lagascea mollis*** CAV., Anal. Cienc. Nat. 6: 333, t. 44, 1803; HOOK. F., Fl. Brit. India 3: 302, 1881.

    Fl & Fr: Apr/Nov

Distribution: Beside the nullah, river and wet places of Chhindwara Dist., viz.,

Atarwada, Bhanadehi, Bodri river bank, Sillewani, Kukrakhapa, Tamia, Patalkot, Chourai, Lavaghogri.

36. ***Launaea nudicaulis*** (L.) Hook. f. sensu stricto, Hook. f., Fl. Brit. India 3: 416, 1881; *Chondrilla nudicaulis* L., Mant. pl. 278, 1767.

    Fl & Fr: Sep/May

Distribution: Bhanadehi, Atarwada, Sausar, Parasia, Tamia, Bicchua and other places of Chhindwara Dist.

37. ***Parthenium hysterophorus*** L., Sp. Pl. 988, 1753; R. S. Rao in J. Bombay Nat. Hist. Soc. 54: 218, 1956.

    Fl & Fr: May/Mar

Distribution: It is an obnoxious weed present throughout Chhindwara Dist., viz., Chhindwara, Harrai, Bicchua, Jamai, Damua, Patalkot, Amarwada, Gangiwada, Delakhri, Umaranala, Karaboh etc.

38. ***Pentanema indicum*** (L.) Ling in Acta Phyt. Sin. 10: 179, 1965. *Inula indica* L., Sp. Pl. ed. 2: 1236, 1763; Hook. f., Fl. Brit. India 3: 297, 1881. *Vicoa indica* (L.) DC. in Wight, Contr. Bot. Ind. 10, 1834.

    Fl & Fr: Sep/Jun

Distribution: Throughout the dry places of Chhindwara Dist., viz., Bhanadehi, Bhartadeo, Parasia, Jamai, Chhindwara, Chand, Damua.

39. ***Pulicaria wightiana*** (DC.) C B. Clarke, Comp. Ind. 128, 1876; Hook. f., Fl. Brit. India 3: 299, 1881. *Poloa wightiana* DC. in Guill., Arch. Bot. 2: 515, 1833.

    Fl & Fr: Aug/Dec

Distribution: Bhartadeo, Kukrakhapa, Tamia.

40. ***Sclerocarpus africanus*** Jacq., Ic. Pl. Rar. 1: 17, t. 176, 1780-1784; Hook. f., Fl. Brit. India 3: 305, 1881.

    Fl & Fr: Mar/Sep

Distribution: Tamia, Patalkot, Chhindi, Bhanadehi, Atarwada.

41. ***Sigesbeckia orientalis*** L., Sp. Pl. 900, 1753; Hook. f., Fl. Brit. India 3: 379, 1881.

    Fl & Fr: Apr/Dec

Distribution: Occurs only in slopes of Tamia hills.

42. ***Sonchus arvensis*** L. var. ***glaber*** HAINES, Bot. Bihar & Orissa 2: 522, 1922.

Fl & Fr: Aug/Apr

Distribution: Throughout the plains of Chhindwara Dist., viz., Chaurai, Umaranala, Gangiwada, Chandangaon etc.

43. ***S. brachyotus*** DC., Prodr. 7: 186, 1838.

Fl & Fr: Sept/Mar

Distribution: Parasia, Newton, Tamia.

44. ***S. oleraceus*** L., Sp. Pl. 794, 1753; HOOK. F., Fl. Brit. India 3: 414, 1881.

Fl & Fr: Aug/Mar

Distribution: Throughout Chhindwara Dist., viz., Parasia, Bhanadehi, Chaurai, Bhartadeo, etc.

45. ***Sphaeranthus indicus*** L., Sp. Pl. 927, 1753; HOOK. F., Fl. Brit. India 3: 275, 1881. (p.p.).

Fl & Fr: Jan/Jul

Distribution: Tamia, Patalkot and Kukrakhapa, Bodri river bank, in cultivated fields of paddy.

46. ***Spilanthes acmella*** (L.) MURR. var. ***oleracea*** C. B. CLARKE, Comp. Ind. 138, 1876; HOOK. F., Fl. Brit. India 3:307, 1881.

Fl & Fr: Jul/Mar

Distribution: Occurs on wastelands near nullah or river banks of Chhindwara, Tamia, Khirsadoh, Kukrakhapa, Karaboh.

47. *S.* ***calva*** DC. in WIGHT, Contr. Bot. Ind. 19, 1834. *S. acmella* var. *calva* (DC.) C. B. CLARKE, Comp. Ind. 138, 1876. *S. acmella* auct. non (L.) MURR.; HOOK. F., Fl. Brit. India 3: 307, 1881.

Fl & Fr: Feb/Apr

Distribution: Cultivated for medicine in Bhanadehi, Chourai, and Chhindwara.

48. ***S. radicans*** JACQ., Collectanea 3: 229, 1789 (publ. 1791); SIVARAJ. & MATTHEW in Anc. Sci. Life 3: 169, 1984.

Fl & Fr: Oct/Jan

Distribution: Danielson College Garden, Kukrakhapa.

49. ***Synedrella nodiflora*** (L.) GAERTN., Fruct. Sem. 2: 456, t. 171, 1791; HOOK. F., Fl. Brit. India 3: 308, 1881. *Verbesina nodiflora* L., Cent. Pl. 1:28, 1755.

Fl & Fr: Throughout the year

Distribution: Chhindwara, Amarwada, Sausar, Jamai, Tamia, Patalkot, Harrai, Bicchua and almost all parts of Chhindwara Dist.

50. ***Tagetes erecta*** L., Sp. Pl. 887, 1753.

Fl & Fr: Almost throughout the year

Distribution: Ornamental. Present in almost all parts of Chhindwara Dist., viz., Parasia, Amarwada, Bhartadeo, Chourai, Jamai, Chhindwara proper.

51. ***T. patula*** L., Sp. Pl. 887, 1753.

Fl & Fr: Sep/Dec

Distribution: Ornamental. Present all over in Chhindwara Dist., viz., Parasia, Umaranala, Sausar, Bhartadeo, Umreth, Chhindwara etc.

52. ***Tithonia diversifolia*** (HEMSL.) A. GRAY in Proc. Amer. Acad. Arts 19:5, 1883. *Mirasolia diversifolia* HEMSL., Biol. Centr. Amer. Bot. 2: 168, t. 47, 1881.

Fl & Fr: Sep/May

Distribution: Tamia, Chhindi, Patalkot, occurring near road side.

53. ***Tridax procumbens*** L., Sp. Pl. 900, 1753; HOOK., F., Fl. Brit. India 3:311,1881.

Fl & Fr: Throughout the year

Distribution: Widely distributed throughout Chhindwara Dist., particularly in wastelands of Chhindwara, Jamai, Karaboh, Chand, Sausar, Pandurna, etc.

54. ***Vernonia cinerea*** (L.) LESS. in Linnaea 4: 291, 1829; HOOK. F., Fl. Brit. India 3: 233, 1881. *Conyza cinerea* L., Sp. Pl. 862, 1753.

Fl & Fr: Mar/Dec

Distribution: A common weed of Chhindwara, Kukrakhapa, Jamai, Parasia.

55. ***V. divergens*** (ROXB.) EDGEW. in J. Asiat. Soc. Bengal. 21:172, 1853; HOOK. F., Fl. Brit. India 3:234, 1881. *Eupatorium divergens* ROXB., Fl. Ind. 3:414, 1832.

Fl & Fr: Jan/Jun

Distribution: Chhindwara, Bhartadeo, Bhanadehi, Dharam tekri.

56. ***Xanthium strumarium*** L., Sp. Pl. 987, 1753, (p.p.); Hook. f., Fl. Brit. India 3:303, 1881 (excl. syn *X. strumarium* Boiss.).

Fl & Fr: Jul/Jan

Distribution: Chhindwara, Tamia, Patalkot, Linga, Umaranala, Harrai, Bhanadehi, Kukrakhapa.

57. ***Zinnia elegans*** Jacq., Collectanea 3: 152, 1789 (publ. 1791).

Fl & Fr: Sep/Mar

Distribution: Ornamental. Chhindwara, Tamia, Junnardeo, Hirdagarh, Parasia, Sillewani-Ghat, Bhanadehi, Atarwada, Chand, Kundipura.

Discussion and Conclusions

Asteraceae stands as the fourth largest family in India (Rao 1994). The present floristic study of the district records of family Asteraceae shows that *Parthenium hysterophorus* is widely distributed. Most genera are represented by only one or two species. The largest genus is *Bumea* with five species, while *Sigesbeckia* is present only in the hilly region of Tamia. Genera like *Guizotia, Tagetes, Helianthus, Carthamus* and *Spilanthes* are being cultivated in Chhindwara Dist. Species of *Acanthospermum, Ageratum, Parthenium, Xanthium, Pentanema, Cichorium* and *Caesulia* are weeds occurring in cultivated fields and wastelands of Chhindwara. *Eclipta alba* and *Spilanthes calva* are being used/cultivated medicinally.

A number of taxa such as *Parthenium hysterophorus, Xanthium strumarium, Tridax procumbens, Ageratum conyzoides* and *Acanthospermum hispidum* dominate practically all the areas and are common weeds.

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Table 1. Flowering, fruiting and uses of members of Asteraceae in Chhindwara District.

Name of species	Fl & Fr	Uses	Part
Acanthospermum hispidum	Jul / Oct	Weed	-
Ageratum conyzoides	May / Dec	Medicine	L
Amberboa ramosa	Jul / Feb	Medicine	WP
Bidens biternata	Aug / Jan	Weed	-
Blainvillea acmella	Apr / Nov	Weed	-
Blumea balsamifera	Nov / Apr	Medicine	L
B. eriantha	Nov / Apr	Medicine	WP
B. lacera	Jan / Jun	Medicine	R & L
B. laciniata	Dec / Mar	Weed	-
B. mollis	Feb / May	Weed	-
Caesulia axillaris	Oct / Apr	Weed	-
Carthamus tinctorius	Feb / Apr	Medicine	F
Centipeda minima	Jan / Dec	Medicine	WP
Chrysanthemum indicum	Oct / Dec	Garden	-
Cichorium intybus	Jan / Jun	Medicine	R & S
Cosmos bipinnatus	Aug / Nov	Weed	-
C. sulphureus	Sep / Jan	Weed	-
Cyathocline purpurea	Dec / May	Weed	-
Dahlia pinnata	Jun / Dec	Garden	-
Echinops echinatus	Oct / May	Medicine	WP
Eclipta alba	Jun / Mar	Medicine	WP
E. prostrata	Jan / Dec	Medicine	R & L
Elephantopus scaber	Oct / May	Medicine	WP
Emilia sonchifolia	Aug / Feb	Medicine	WP
Erigeron asteroides	Dec / May	Medicine	WP
Eupatorium triplinerve	Sep / Jan	Medicine	WP
Gaillardia pulchella	Mar / Sep	Garden	-
Galinsoga parviflora	Dec / Apr	Weed	-
Gnaphalium luteo-album	Jan / Dec	Weed	-
G. pensylvanicum	Jan / Nov	Weed	-
G. purpureum	Aug / May	Weed	-
Guizotia abyssinica	Sep / Dec	Medicine	-
Gynura nitida	Dec / May	Weed	-

Name of species	Fl & Fr	Uses	Part
Helianthus annuus	Oct / Dec	Medicine	WP
Lagascea mollis	Apr / Nov	Weed	-
Launaea nudicaulis	Sep / May	Medicine	L
Parthenium hysterophorus	May / Mar	Weed	-
Pulicaria wightiana	Aug / Dec	Weed	-
Sclerocarpus africanus	Mar / Sep	Weed	-
Sigesbeckia orientalis	Apr / Dec	Medicine	WP
Sonchus arvensis	Aug / Apr	Medicine	WP
S. brachyotus	Sep / Mar	Medicine	L & F
S. oleraceus	Aug / Mar	Medicine	WP
Sphaeranthus indicus	Jan / Jul	Medicine	WP
Spilanthes acmella	Jul / Mar	Medicine	WP
S. calva	Feb / Apr	Medicine	F & L
S. radicans	Oct / Jan	Weed	-
Synedrella nodiflora	Jan / Dec	Weed	-
Tagetes erecta	Jan / Dec	Medicine	F & L
T. patula	Sep / Dec	Medicine	F & L
Tithonia diversifolia	Sep / May	Weed	-
Tridax procumbens	Jan / Dec	Medicine	WP
Vernonia cinerea	Mar / Dec	Medicine	WP
V. divergens	Jan / Jun	Weed	-
Xanthium strumarium	Jul / Jan	Medicine	WP
Zinnia elegans	Sep / Mar	Garden	-

WP = Whole Plant S = Seed

F = Flower R = Root

L = Leaf

The Genus *Atractylodes* DC. (Compositae-Cynareae) in Far East Russia

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Abstract

The present paper deals with the morphological and anatomical structure and surface ultrasculpture of achenes in *Atractylodes ovata* (THUNB.)DC. The structure of pericarp and seed coat in this species differs distinctly from that of other East Asiatic members of the tribe Cynareae. The study is based on herbarium specimens and living plants growing wild in the South of Far East Russia and reveals the variability in *A. ovata* caused by environmental conditions.

Introduction

The genus *Atractylodes* DC. belongs to the subtribe Carlineae O. HOFFM. (HOFFMANN 1890-94) of the tribe Cynareae LESS., but in later publications (DITTRICH 1977, BREMER 1987, TAKHTAJAN 1987) Cassini's concept (CASSINI 1817) was accepted and the tribe Carlineae considered as a separate tribe. In recent work by BREMER and other authors (BREMER et al. 1992, BREMER 1994), who used results received by different methods, the Carlineae were again regarded as a subtribe of the tribe Cardueae, which was thus understood in a broad sense. For the decision on the systematic position of *Atractylodes* we used carpological methods, a generally acknowledged tool in the taxonomy of the family (cf. DITTRICH 1966 and subsequent papers). The study of ultrasculpture of fruit surface is important especially for taxa with small fruits as in some species of Compositae.

The presence of lignified, palisade-like, thickened, radially elongated epidermal cells of seed coat is characteristic for the members of the tribe Cynareae (DITTRICH 1977 and other papers). However, in some species of the subtribes Carlinineae and Echinopsidineae the epidermal cells of seed coat are parenchymatous, narrowly

oblong, thin-walled, tangentially elongated and have neither thickened nor lignified walls (LAVIALLE 1912, FOURMENT et al. 1956).

Material and Methods

Plant materials and mature achenes of *A. ovata* were collected during 1995 through 1997 from several populations growing wild in the south of Russian Far East. We also used herbarium specimens from different regions of Korea (deposited at the Institute of Biology and Soil Science Far East Branch of RAS). For the micromorphological observations, achenes were softened in a solution of glycerine, ethanol and water (1:1:1) during a few days, embedded in paraffin and cut by microtome. Sections were made at a thickness of 8-15 μm. Longitudinal and cross sections were stained in safranin. For scanning electron microscopic (SEM) studies the surface of achenes was coated with gold and photographed using a Jeol Scanning Microscope (JSM-U3). The drawings were made by the present authors.

Specimens investigated:

Russia, Primorsky Territory:

Olginsky district, mountain Zarod, 14.08.97, E.V. BOYKO, R.V. DUDKIN

Khasansky district, town Slavyanka, 26.07.91, R.V. DUDKIN; village Ryazanovka, 06.09.1974, E.V. BOYKO; village Barabash, 30.05.1972, B. MACHANKOV; Vityaz Inlet, 04.07.97, E.V. ZAREMBO

Shkotovsky district, village Smolyaninovo, 23.07.1996, P. G. GOROVOY

Oktyabrsky district, village Chernyatino, 25.07.73, I. S. DIDENKO

Ussuriysky district, Ussuriysky reserve, valley of Komarovka river, 29.06.1968, E.V. BOYKO

Anuchinsky district, valley of Berestovka river, 18.07.1970, D. D. BASARGIN

Michailovsky district, valley of Ilistaya river, 16.08.1978, N. D. TELEKALO

Partizansky district, village Ekaterinovka, 21.09.1974, E.V. BOYKO

Russia, Khabarovskiy Territory:

Radde village, 31.08.89, K. P. ULANOVA & E.V. BOYKO

Chaldonca mountain, 23.08.72, E. ZDOROVJEVA & S. VOLKOVA.

Morphological and anatomical data

Fruit. The mature achenes are from 6 to 7,5 mm long, 1,5-3 mm wide, narrowed towards the base, and covered by white hairs 0,8-1mm long. Each hair is terminated by two acuminate cells equal in length or unequal (Fig. 2B). The attachment of achenes to the receptacle is not oblique, but in a straight line. Pappus 8-10 mm long, yellowish, consisting of plumose bristles in a single ring. Pappus bristles have a distinct axis, 0,12-0,24 mm thick, and thin white hairs, 1mm long, are emitted from the main axis at an angle of 20-30° (Fig. 2C).

Pericarp. Cross section of mature fruit shows more or less elliptically quadrangular outline. The thickness of the pericarp is 0,05-0,055 mm. Anatomically, the pericarp is differentiated into two zones. There is a layer of uniformally thickened epidermal cells, elongated in tangential direction, 0,09-0,18 mm long, 0,03-0,05 mm (usually 0,035) high. The zone of thickened parenchymatous cells, forming one or two layers between ribs, and four or six in ribs, is followed by a zone of epidermal cells.

Seed coat (testa). It is made up of small, thin-walled epidermal cells, elongated in the tangential direction, and compressed parenchymatous cells with two vascular bundles.

Endosperm. The endosperm is one-layered, consisting of thin-walled cells with distinct inner space filled up with grainy substance.

The ultrasculpture of seed surface in *A. ovata* is cellularly diamond-shaped, with radial walls of epidermal cells raised above seed surface. Outer tangential walls of the cells are curved.

Thus, the basic pattern of morphological and anatomical structure of achenes in *A. ovata* closely resembles that of *Carlina acaulis* and *Atractylis gummifera* (Lavialle 1912, Fourment et al. 1956). Our observations may be useful in refining the diagnostic features of subtribe Carlinineae.

Distribution and polymorphism

A.ovata is a characteristic representative of the Manchurian Province of Eastern Asiatic Floristic Region (Takhtajan 1986) and its natural distribution range includes Prymorje, province Amurensis (Russia), north-east China, Japan, and Korea. The floristic structure of this region is characterized by high extent of endemism and defined by the complex of the special ecological and geographical conditions of monsoon climate. These specific conditions quite often are the cause of plant polymorphism in natural populations. Such polymorphism is known in *A. ovata*. Therefore, there is no uni-

form opinion on species taxonomy in the genus *Atractylodes* in botanical literature. The species *A. ovata* either is divided into some species or is understood widely. V. L. Komarov (1907) reported about variability of *A. ovata* and on the basis of leaf morphology described three new forms: f. *ternata*, f. *pinnatifolia*, f. *lyratifolia* (besides he pointed out two more forms: f. *simplicifolia* Loes., f. *amurensis* Freyn). S. Kitamura (1937) recognized two species: *A. coreana* (Nakai) Kitamura with entire, sessile leaves, and *A. japonica* Koidzumi ex Kitamura with pinnatipartite, petiolate leaves. J. Ohwi (1965) followed Kitamura and recognized one species in Japan, viz. *A. japonica*. Shih Chu (1987) listed five species for China, viz. *A. coreana*, *A. japonica*, *A. lancea* (Thunb.) DC., *A. carlinoides* (Hand.-Mazz.) Kitam., and *A. macrocephala* Koidz. T. Lee (1993) mentioned only species, viz. *A. japonica* with pinnatisect leaves.

This paper reviews the variability of diagnostic features of *A. ovata* in natural populations. The study of herbarium specimens and plants from various habitats has revealed the polymorphism in height of plants, leaf-shape (from entire to pinnatisect with 3—5 segments), outline of leaf segment (from rounded to narrowly ovate-acuminate), extent of stem branching, and length of petiole. Tall specimens growing in oak forest under the cover of trees have branching stems, numerous inflorescences, long-petiolate, pinnatisect (3- to 5-sect) stem leaves, and sessile radical leaves. In comparison, undersized plants growing on hills without shrubs and trees are characterized by unbranched stems, solitary inflorescences, and entire, sessile small leaves. In our opinion the polymorphism of *A. ovata* in the south of Russian Far East is caused by enviromental conditions, and heteromorphic populations should be considered as just ecological forms of a single species.

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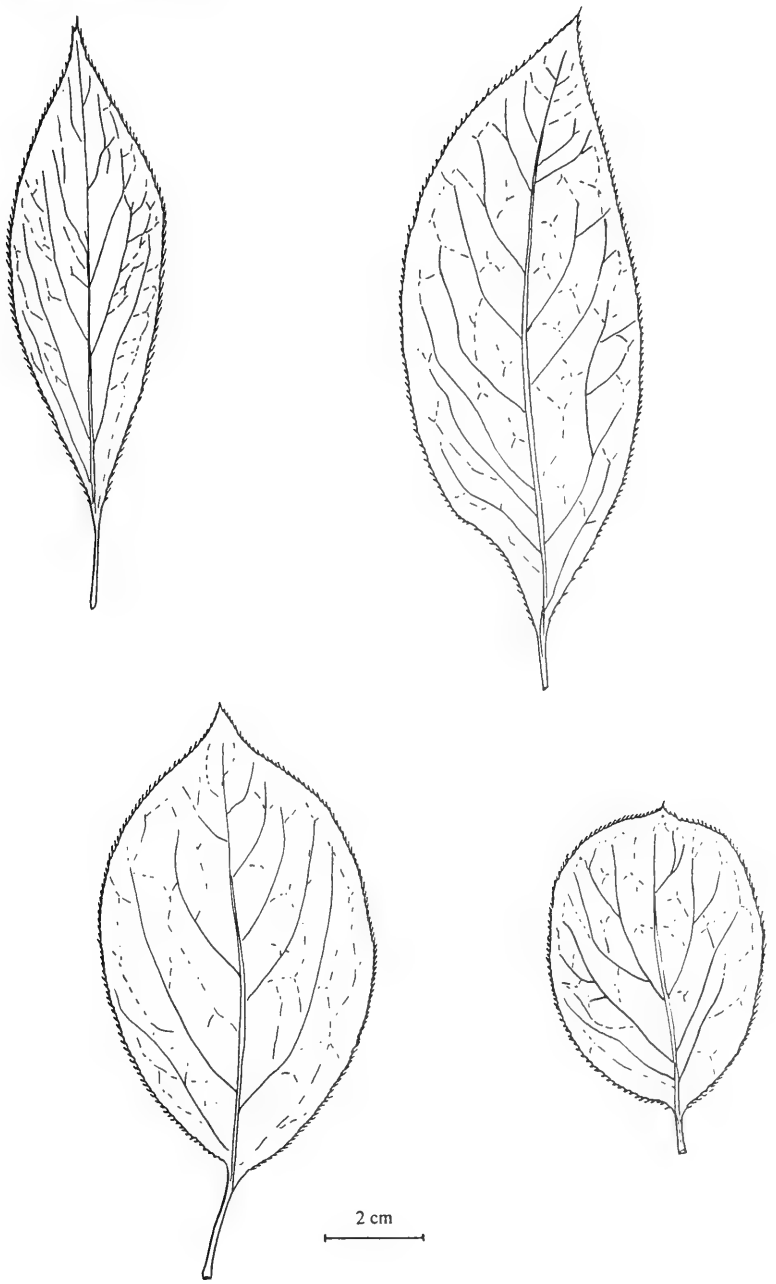

Fig. 1a. Variation in leaf morphology in *Atractylodes ovata.*

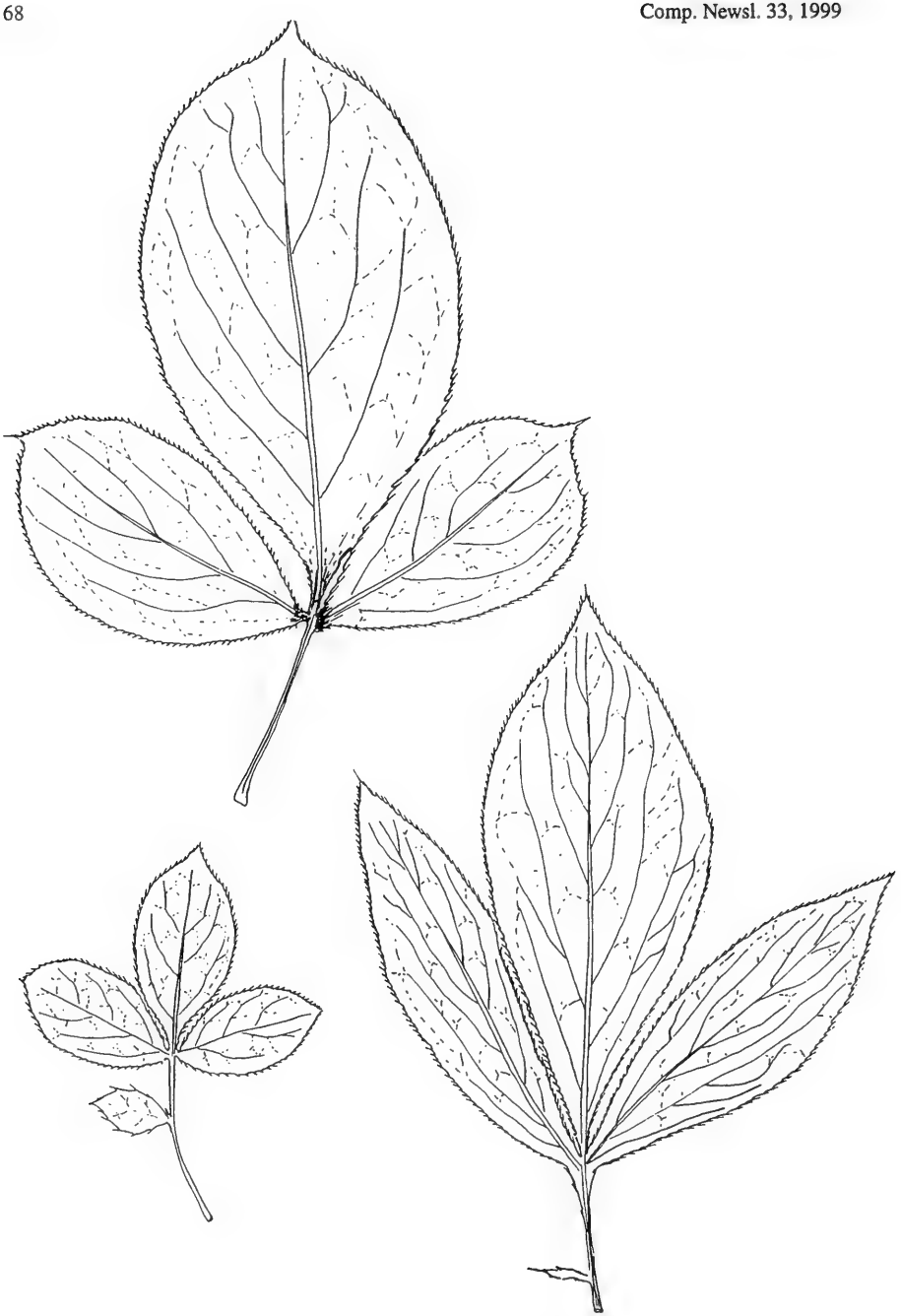

Fig. 1b. Variation in leaf morphology in *Atractylodes ovata* (contd.).

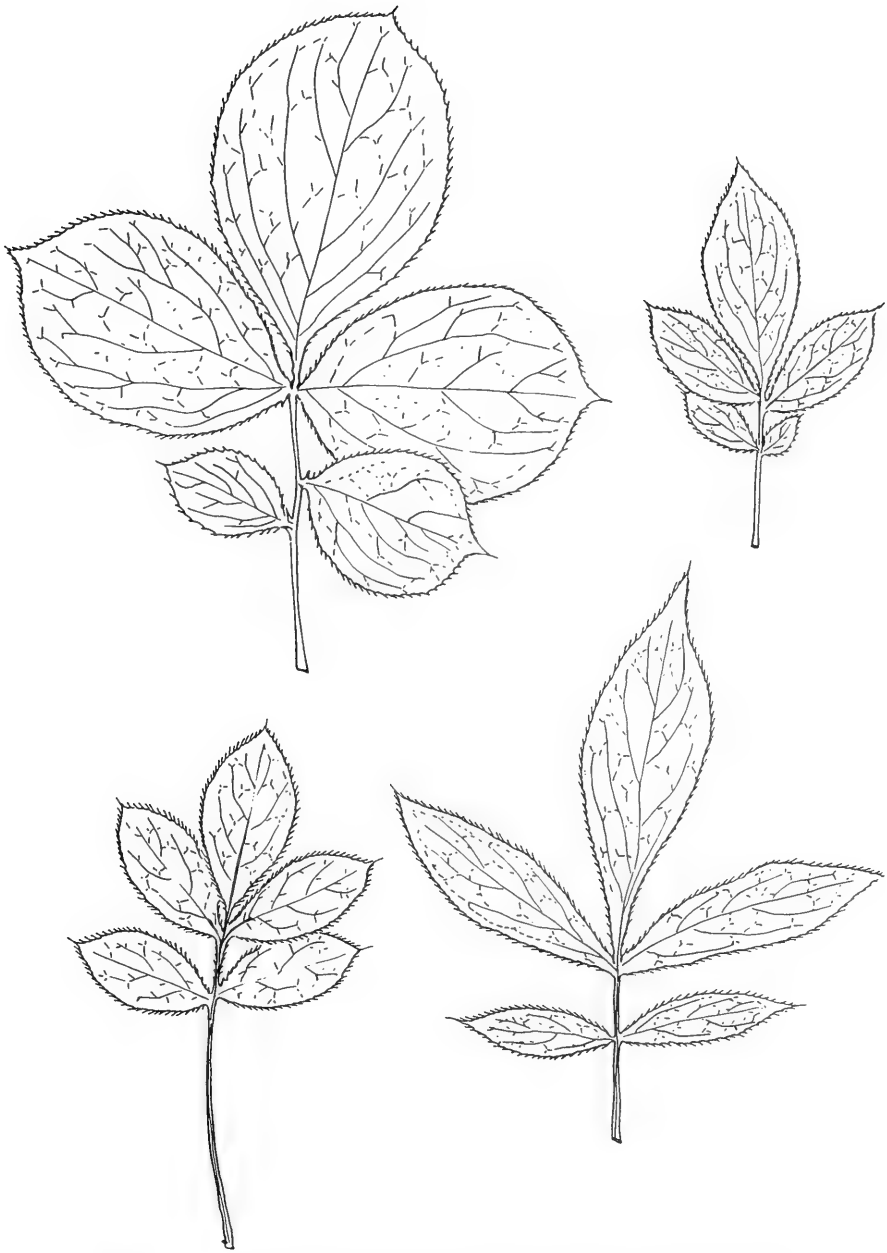

Fig. 1c. Variation in leaf morphology in *Atractylodes ovata* (contd.).

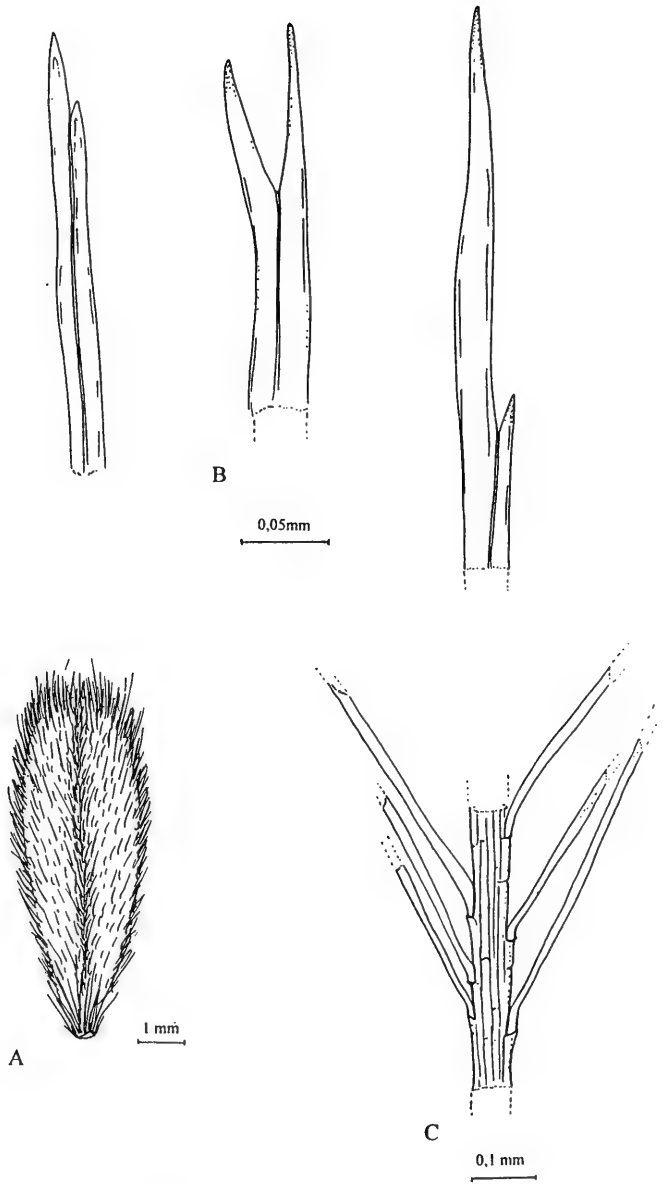

Fig. 2. *Atractylodes ovata*

A: Achene without pappus. B: Twin apex of achene hairs. C: Detail of pappus bristle showing main axis and numerous collateral hairs deviated at an angle of 20-30^0.

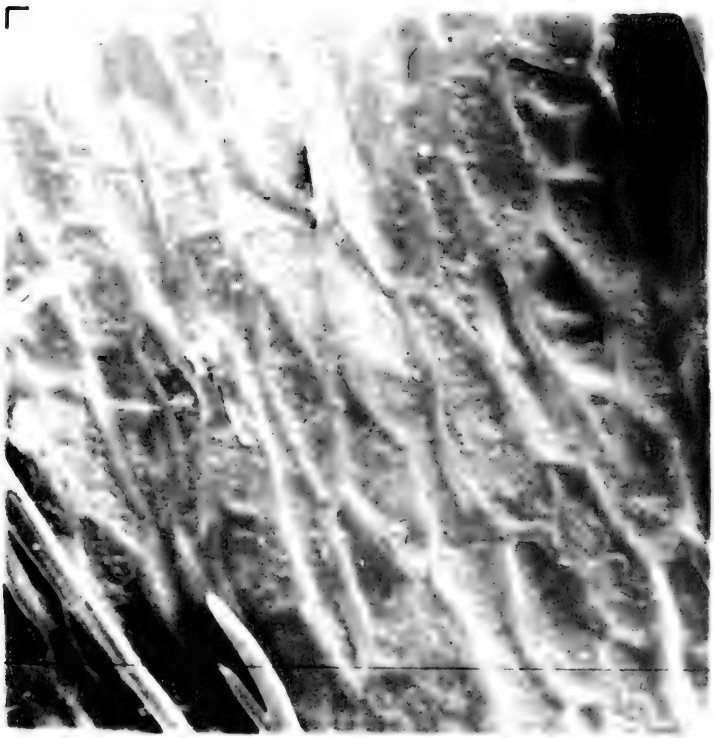

Fig. 3. Structure of achene surface of *Atractylodes ovata* (SEM micrograph) × 1000.

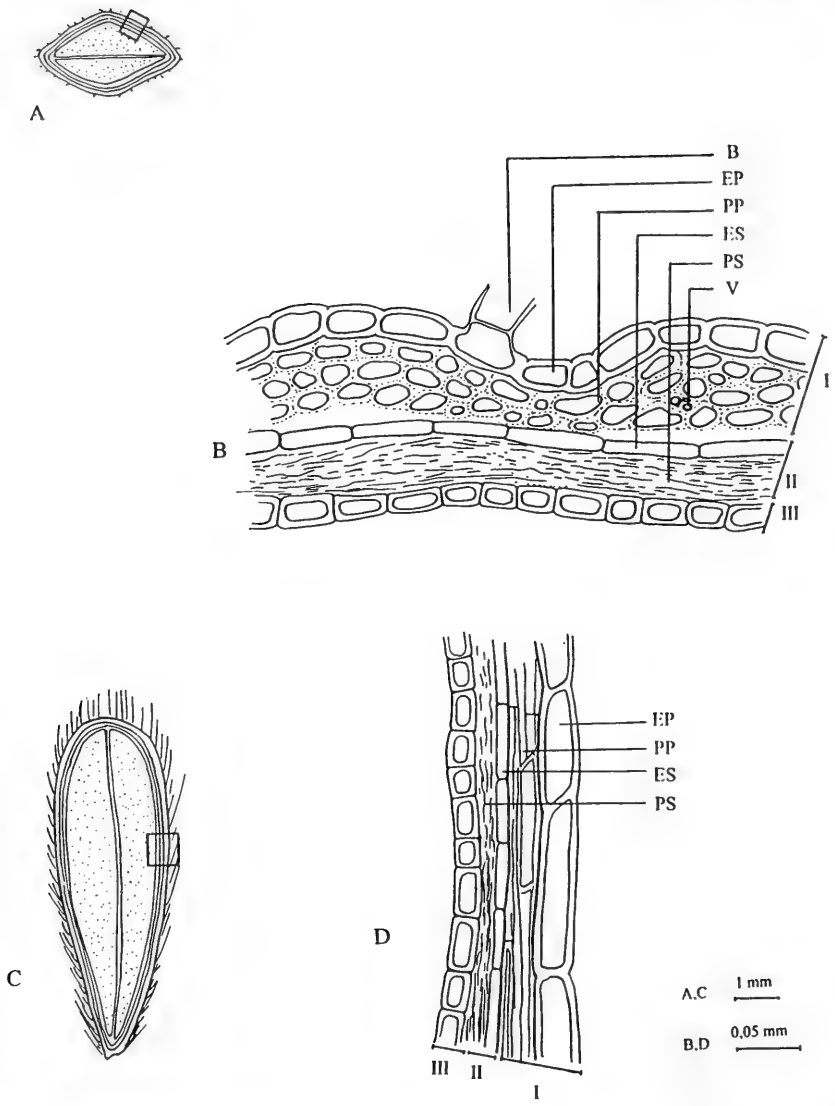

Fig. 4. ***A. ovata.*** A: Simplified cross section of achene. B: Part of cross section of mature achene with anatomical details. C: Simplified longitudinal section of achene. D: Part of longitudinal section of mature achene with anatomical details .I-pericarp; II-seed coat; III-endosperm. Base of hair (B); epidermal cells of pericarp (EP); parenchymatous cells of pericarp (PP); epidermal cells of seed coat (ES); parenchymatous cells of seed coat (PS); vascular bundles (V).

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